SUPREME COURT OF THE UNITED STATES

OCTOBER TERM, 1944

No. 56

SOUTHERN PACIFIC COMPANY,
a corporation,
Appellant,

vs.

STATE OF ARIZONA ex rel. JOE CONWAY,
Attorney General of the State of
Arizona,
Appellee.

BRIEF FOR APPELLANT

VOLUME II — THE FACTS

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FOREWORD

This second volume of appellant's brief, submitted as a supplement to the brief on the law (Vol. I), contains a discussion of the findings of fact adopted by the trial court (R. 3879-4034), with particular reference to the evidence and other matters of record which support those findings.

The purpose of this discussion is to assist this Court, if it should conclude that the Supreme Court of Arizona has

undertaken to reverse the trial court's findings of fact (a point which we discuss in some detail in Subdivision 6 of the argument in our brief on the law: Vol. I, at pp. 314-330), in that examination and determination which this Court has declared that it is bound to make whenever federal rights, duly asserted, have been denied by a state court because of findings of fact not supported by, or contrary to, the evidence.

No findings of fact in this cause appear of record, other than those made and adopted by the trial court. No proposed amendments to or substitutions for such findings were ever presented to the State Supreme Court, by the State, upon its appeal to that court from the judgment of the trial court; nor were any new findings, or any specific changes or even general suggestions for changes in the findings already made, adopted by the State Supreme Court or even discussed by it in its opinion. The trial court's findings thus constitute the only concrete and specific findings of fact, or proposals with respect thereto, which are of record before this Court, and so afford the natural and logical objective of this discussion of the evidence.

In this review we show that those findings are fully in accord with the evidence, and present an accurate review and summary of all the evidence; that they respond to the issues of fact as presented by the pleadings in the case; and that no other, contrary or inconsistent findings, if any should now be proposed, would be fairly warranted or adequately supported upon the record.

For the sake of easy reference, we here employ the same topical headings as in the findings. Citations of the oral testimony are by names of witnesses and pages of the printed record; citations of exhibits are by the numbers assigned at the time of their tender in evidence.

We suggest that each subdivision of each finding, as it appears in the printed record, should be reviewed before reading the section of this brief carrying the same number and topical heading. The discussion and review of the evidence herein has been written with that method of review in mind, so that duplication or repetition in the recital of facts may be avoided.

THE PREAMBLE (R. 3887).

The preamble is simply a brief history of the proceedings in this case up to and including the rendition of the trial court's initial decision. All of the recitals in the preamble relate to matters of record, as to which no dispute or challenge is possible.

I.

DEFINITION OF TERMS (R. 3888)

For convenience it was believed desirable to incorporate in the initial paragraph of the findings a definition of certain terms frequently used thereafter.

The terms "Train-Limit Law" and "the law" were generally used, by both counsel and witnesses, during the course of the trial and later proceedings, to designate the statute under which the case is brought, the validity of which is challenged herein.

The terms "long trains" and "short trains" are used to apply, respectively, to trains of more than 70 freight or other cars (exclusive of caboose), or more than 14 passenger cars, and trains containing less than those numbers of cars. These terms were also commonly used by both counsel and witnesses, during the course of the litigation. The definitions correspond to the limitations fixed by the Train-Limit Law, and in fact incorporate the law's limitations by express reference.

"Interstate trains" are defined as all trains which carry any interstate commerce or are engaged in interstate transportation. This is the ordinary definition, frequently used in decisions of courts and the Interstate Commerce Commission.

The definition of "standard long-train operation", as the practice of hauling freight traffic in long freight trains, and passenger traffic in long passenger trains, whenever efficiency and economy can thereby be subserved, and of handling such traffic in short trains when economy and convenience are not promoted by long-train operation, is likewise desirable. The standard long-train practice, as thus defined, does not contemplate that *every* train operated shall be a long train; but only that traffic shall be moved in such units when greater efficiency and economy results.

The expression "the affected territory" is frequently used in the findings to designate the lines in Arizona, and in the adjacent portions of California, New Mexico, and Texas where, according to the testimony, the Train-Limit Law affects the railroad operations carried on by appellant.

II.

NATURE OF THE CASE: THE PARTIES INVOLVED (R. 3889-3890).

(a) THE PARTIES (R. 3889).

This paragraph simply reproduces, in summary form, certain portions of the complaint and the answer, the accuracy of which is either not challenged, or is apparent on its face. The finding is necessary, as a preliminary to the remainder of the findings of fact, in that it sets forth the status and identity of the parties to the cause.

Complaint, Par. (1) (R. 1).
Answer, Par. (1); Part III (R. 7).

(b) THE ISSUES (R. 3889-3890).

This paragraph is likewise a summary of certain essential allegations and admissions of the complaint and the answer. It is desirable to have such a summary appear at the outset of the findings, in order that the character of the issues involved may be set forth in advance of the more specific findings upon the various points presented by the testimony at large.

III.

DESCRIPTION OF DEFENDANT'S[1] LINES OF RAILROAD (R. 3680-3897).

(a) GENERAL DESCRIPTION OF THE SYSTEM (R. 3890-3891).

This finding describes the appellant's railroad system as to general location, and shows also that in view of its connections with other interstate carriers, it enters into and forms a part of the nation-wide railroad transportation system. The finding is essential, as a preliminary to the further discussion of appellant's position as an interstate carrier which appears in connection with later findings, particularly those relating to the effect of the law upon appellant's operations in interstate commerce.

Answer, Par. 2, Part III (R. 7-9).
Sines, R. 58-61.
Exhibits 1 (R. 2851), 175 (R. 1284).

There is also included in the findings, as a proper foundation for later detailed discussion, a brief statement of the total system mileage, the total investment in fixed property (not including equipment), and the mileage in the main lines in the territory immediately affected by the law: i.e., the lines of Arizona, including also the entire main-line mileage between Yuma and El Paso, Texas.

Masson, R. 860-861.
Exhibits 110 (R. 2964), 111 (R. 2965) 115 (R. 2975).

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[1]The defendant in the trial court is appellant before this Court; however, we preserve for the purpose of this discussion the topical headings as they appear in the trial court's findings of fact.

The transcript references appended to the finding include references to the oral testimony and the exhibits which directly describe appellant's system, and also to the testimony of operating officials of other railroads, showing that the appellant actually participates in through transportation service with these other carriers, and thus enters into and becomes a part of the nation-wide railroad transportation system.

Wright, R. 151-158; *Kirk*, R. 253-258; *Young*, R. 301-302; *Fertig*, R. 500-501, 503-505, 511; *Green*, R. 537-538; *Kraemer*, R. 561-563; *Randall*, R. 591; *Triem*, R. 634; *Hammond*, R. 667-668; *Warfel*, R. 691; *Peckenpaugh*, R. 754-755; *Mahoney*, R. 1024, 1037-1039; *F. P. McDonald*, R. 1615; *Judson*, R. 1625.

(b) THE LINES IN THE AFFECTED TERRITORY (R. 3891-3896).

(1) Location; principal stations; double track (R. 3891-3892): This paragraph contains a description in some detail of the appellant's main lines in the territory between Yuma, Arizona, on the west, and El Paso, Texas, on the east, with some reference as well to the main lines between Los Angeles and Yuma, and between El Paso and Tucumcari, New Mexico; particular mention being made of the principal stations, the extent of single and double track, and the points where the main lines enter and leave Arizona. Reference is also made to the branch lines in Arizona, principally for the sake of completeness; the fact being that the law apparently has little, if any, effect upon such branch-line operations. For convenient refer-

ence, we here insert a copy of the system map in evidence as Exhibit 1 (R. 2851).

Sines, R. 58-59, 66-67; *Masson*, R. 861-863.
Exhibits 1 (R. 2851), 115 (R. 2975), 154 (R. 3028), 175 (R. 1284).

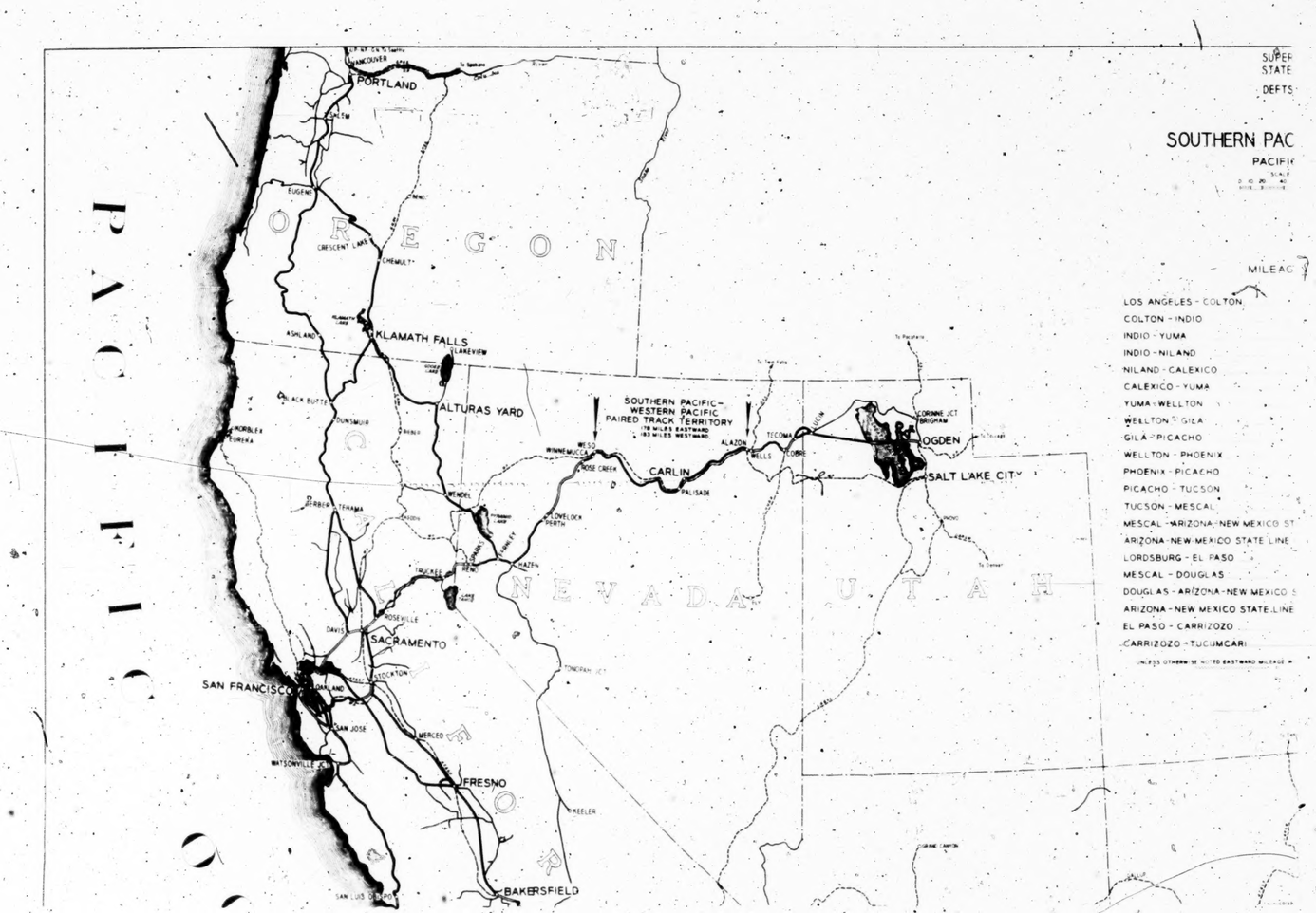
The finding also sets forth that the line principally used by appellant for the handling of interstate freight traffic across Arizona extends from Yuma via Gila, Tucson, Bowie, Arizona, and Lordsburg, New Mexico, to El Paso, Texas. That line is frequently referred to in the findings as appellant's Yuma-Gila-Lordsburg line. The two auxiliary main lines via Wellton, Phoenix and Picacho, and via Mescal, Douglas and Anapra, which handle a lesser proportion of the interstate freight traffic moving across Arizona, are for brevity referred to, the former as the Phoenix line, and the latter as the Douglas line. A substantial proportion of the passenger traffic across the state is routed over these two lines; in fact, the major proportion of the passenger traffic between Picacho and Yuma moves via Phoenix.

Masson, R. 861; *Sines*, R. 1375; *Herbert*, R. 1653-1654, 1663, 1665-1668.
Exhibits 1 (R. 2851), 175 (R. 1284), 176 (R. 3065).

This paragraph corresponds to and largely reproduces part of paragraph 2 of Part III of the answer (R. 7-8).

(2) Ruling grades and curvatures (R. 3893-3895):

This subparagraph describes the grade conditions encountered in the affected territory, dealing first with the



SUPERIOR COURT PIMA CO. ARIZONA
STATE v. S.P.CO. NO 20087
DEFTS EX NO _____ (WITNESS _____)

SOUTHERN PACIFIC COMPANY

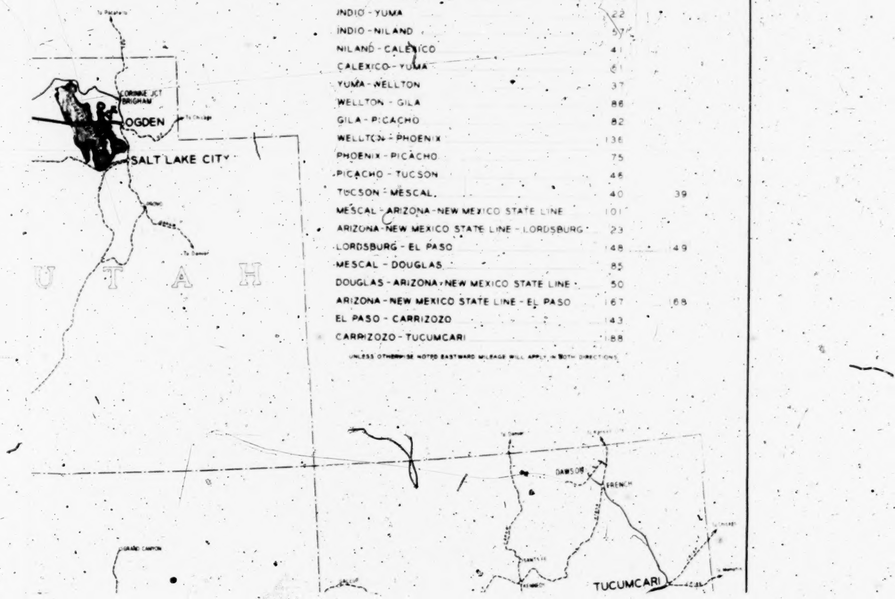
PACIFIC LINES

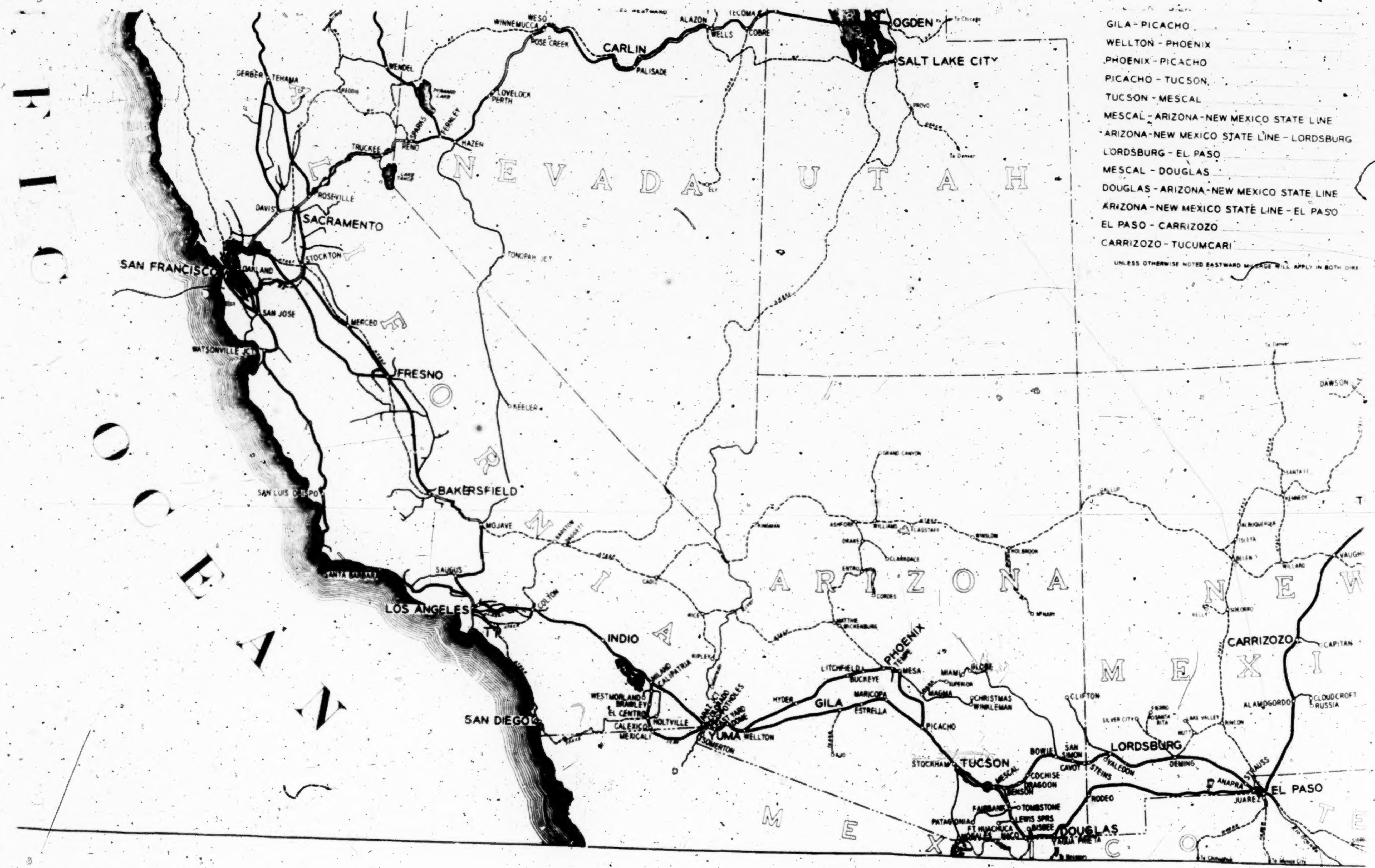
SCALE IN MILES

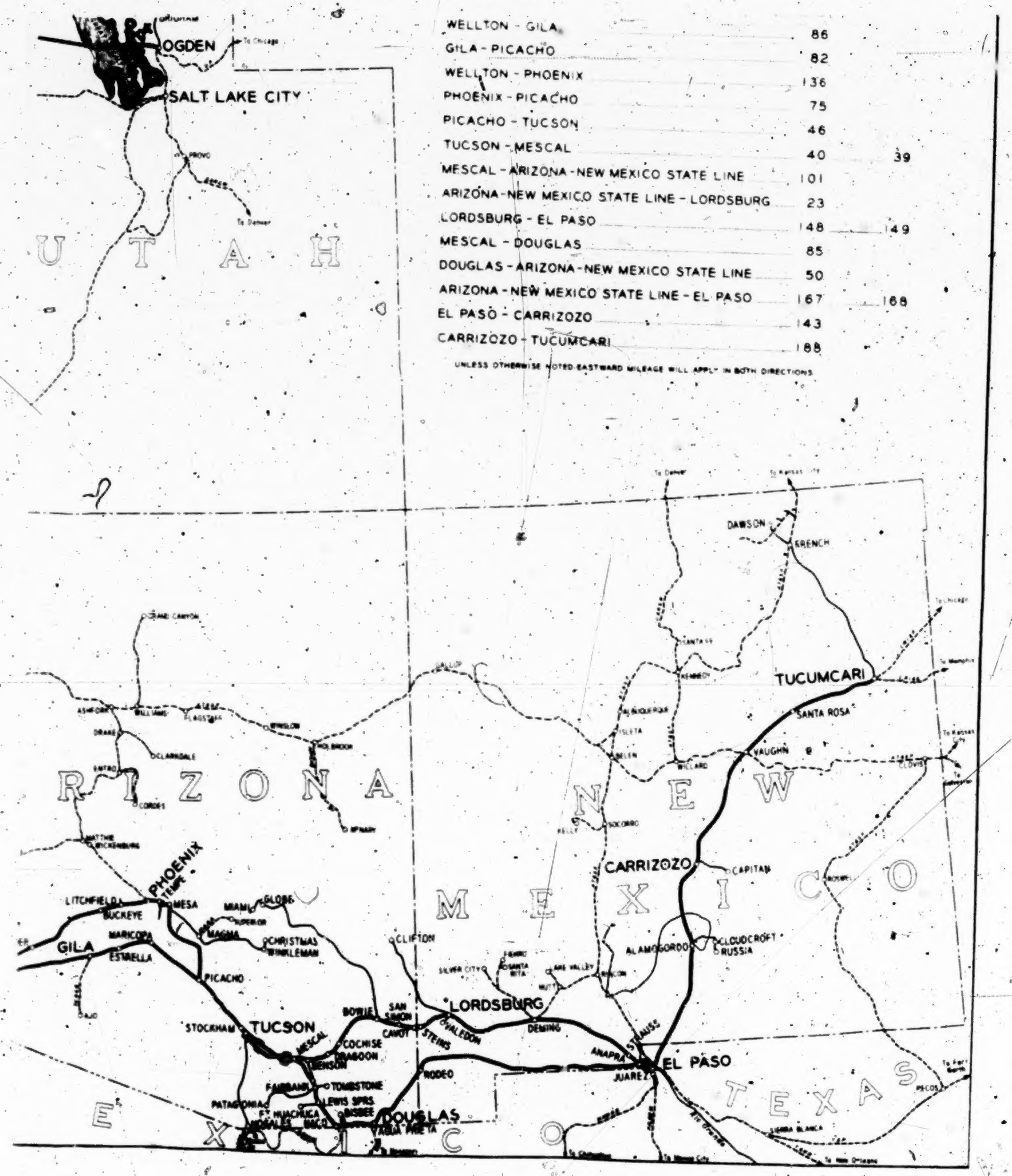
MILEAGE TABLE

	EASTWARD	WESTWARD
LOS ANGELES - COLTON	59	
COLTON - INDIO	72	
INDIO - YUMA	22	
INDIO - NILAND	57	
NILAND - CALEXICO	4	
CALEXICO - YUMA	61	
YUMA - WELLTON	37	
WELLTON - GILA	88	
GILA - PICACHO	82	
WELLTON - PHOENIX	136	
PHOENIX - PICACHO	75	
PICACHO - TUCSON	46	
TUCSON - MESCAL	40	39
MESCAL - ARIZONA - NEW MEXICO STATE LINE	101	
ARIZONA - NEW MEXICO STATE LINE - LORDSBURG	23	
LORDSBURG - EL PASO	48	49
MESCAL - DOUGLAS	85	
DOUGLAS - ARIZONA - NEW MEXICO STATE LINE	50	
ARIZONA - NEW MEXICO STATE LINE - EL PASO	67	68
EL PASO - CARRIZOZO	43	
CARRIZOZO - TUCUMCARI	88	

UNLESS OTHERWISE NOTED EASTWARD MILEAGE WILL APPLY IN BOTH DIRECTIONS




GILA - PICACHO
WELLTON - PHOENIX
PHOENIX - PICACHO
PICACHO - TUCSON
TUCSON - MESCAL
MESCAL - ARIZONA - NEW MEXICO STATE LINE
ARIZONA - NEW MEXICO STATE LINE - LORDSBURG
LORDSBURG - EL PASO
MESCAL - DOUGLAS
DOUGLAS - ARIZONA - NEW MEXICO STATE LINE
ARIZONA - NEW MEXICO STATE LINE - EL PASO
EL PASO - CARRIZOZO
CARRIZOZO - TUCUMCARI
NEVADA
UTAH
ARIZONA
NEW MEXICO
MEXICO
OCEAN
OGDEN
SALT LAKE CITY
CARLIN
SACRAMENTO
SAN FRANCISCO
FRESNO
BAKERSFIELD
LOS ANGELES
INDIO
SAN DIEGO
YUMA
WELLTON
GILA
PHOENIX
TUCSON
LORDSBURG
DOUGLAS
EL PASO
CARRIZOZO


WELLTON - GILA 86
GILA - PICACHO 82
WELLTON - PHOENIX 136
PHOENIX - PICACHO 75
PICACHO - TUCSON 46
TUCSON - MESCAL 40 39
MESCAL - ARIZONA - NEW MEXICO STATE LINE 101
ARIZONA - NEW MEXICO STATE LINE - LORDSBURG 23
LORDSBURG - EL PASO 148 149
MESCAL - DOUGLAS 85
DOUGLAS - ARIZONA - NEW MEXICO STATE LINE 50
ARIZONA - NEW MEXICO STATE LINE - EL PASO 167 168
EL PASO - CARRIZOZO 143
CARRIZOZO - TUCUMCARI 188
UNLESS OTHERWISE NOTED EASTWARD MILEAGE WILL APPLY IN BOTH DIRECTIONS
OGDEN
SALT LAKE CITY
UTAH
ARIZONA
NEW MEXICO
TEXAS
MEXICO
TUCUMCARI
CARRIZOZO
PHOENIX
GILA
TUCSON
LORDSBURG
DOUGLAS
EL PASO

grade conditions in the territory between Indio, California, and Lordsburg, and then more generally with the grades and curvatures east of Lordsburg and west of Indio. This finding is based largely on the descriptive testimony offered through Witness Kirkbride, and also upon the showing of grades and curvatures which appears in detail upon the profiles introduced in evidence by and through that witness.

The finding itself responds to an allegation embodied in paragraph 2 of Part III of the answer (R. 8-9). That allegation relates particularly to grade conditions in southern Arizona and New Mexico. The finding as proposed includes reference to the grades encountered in the California portion of the affected territory, because they are material to the consideration of the ultimate effect of the law upon appellant's freight and passenger-train operations.

Kirkbride, R. 1126-1127, 1176-1177.
Exhibit 155 (R. 3029).

We call particular attention to the comparatively favorable operating conditions which exist on the main lines throughout the affected territory, and particularly those portions east of Yuma. Between Yuma and Tucson the line ascends eastward on comparatively gentle grades, which nowhere exceed 1 per cent, except for the short distance from Lava to Sentinel, a distance of 4.1 miles, and from Gila to Estrella, 18.9 miles, where the ruling grade in each case is 1.02 per cent.

There are long stretches between Yuma and El Paso where the track is level or nearly so, or the grades nominal. There are four comparatively short districts east of

Tucson, three for eastward traffic and one for westward traffic, where the opposing grades are somewhat more severe. These are all between Tucson and Lordsburg. Between Tucson and Mescal, about 40 miles, the ruling grade eastward is 1.06 per cent. From Benson to Dragoon, about 21 miles, the ruling grade is 1.4 per cent; and from San Simon to Steins, 14.7 miles, the ruling grade is 1.4 per cent. Westward from Lordsburg there is a very short ruling grade of 1.4 per cent near the summit of Steins Pass; and between Benson and Mescal, about 9 miles, the westward ruling grade is 1.4 per cent. The only other grade in excess of 1 per cent opposed to westward traffic is between Cochise and Dragoon, where the ruling grade is 1.1 per cent, for about 12 miles.

The curvatures, like the grades, are comparatively light and infrequent upon the lines in the affected territory. Less than one-sixth of the total main-line mileage between Yuma and El Paso via Gila and Lordsburg consists of curved track; and there are only 5.5 miles of track in that line (or less than 1 per cent), consisting of curves of more than 6 degrees. Curvatures on the alternate main lines are similarly of minor importance.

In all cases, where curvatures exist in grade territory, the grades are compensated for the curves, in that the rise of the line, expressed in feet of distance per mile, or in percentage, is reduced around each curve so that the combined effect of the resistance to the movement of traffic afforded by the grade itself, and also by the curvature considered apart from the grade, are together equal to and in all events not greater than the resistance contrib-

uted by the grade itself upon a corresponding and usually adjacent stretch of "tangent" (straight) track. In other words, in territory where grades and curves are both encountered, the ruling grade, including allowance for resistance afforded by curves, may be expressed in terms of percentage rise alone, because all the grades are "compensated." It may be added that this practice of compensating for curves in grade territory prevails on all parts of appellant's Pacific Lines.

Kirkbride, R. 1131-1136, 1139-1140, 2190-2193, 2194-2196.

Exhibits 155 (R. 3029), 175 (R. 1284), 301 (R. 2097), 302 (R. 2101), 303 (R. 2102), 309, 310 (R. 2210).

In districts other than in Arizona where 1.4 per cent or heavier grades are encountered, the operation of long trains is not prevented nor even hampered by the grade and curve conditions. Such long-train operation is, and has been in fact, the regular and standard operating practice of the appellant; and, as shown elsewhere in the testimony and in the findings predicated thereon, it is a general practice on practically every other major railroad in the United States, under conditions which are in many instances less favorable than in Arizona.

Kirkbride, R. 1176-1178; and see *Findings* VII(b), R. 3915-3920, VIII(b), R. 3937, and VIII(f), R. 3945-3946, with annotations.

(3) **Helper districts (R. 3985-3986):**

In this subdivision helper districts are defined; and the location of the freight helper districts in Arizona specified.

We emphasize the point that the mileage of the helper districts in the affected territory east of Yuma is comparatively small. There are less than 95 miles of regular freight helper districts on the main lines between Yuma and El Paso, although, as shown by subparagraph (a) of this finding, the total mileage of the main lines between Yuma and El Paso is 1,069 road miles.

For the sake of completeness this finding includes a reference to the helper districts between Colton and Indio, California. These districts are a part of the affected territory, in that the enforcement of the law affects appellant's operations, particularly of passenger trains, as far west as Los Angeles.

Dyer, R. 1116-1118; *Sines*, R. 1414-1415, 1417-1420, 2285-2286.

Exhibits 155 (R. 3029), 175 (R. 1284).

(4) The affected lines well constructed (R. 3896):

This subparagraph summarizes into two short sentences the extensive testimony of witnesses Kirkbride and J. B. Baker, whereby the essential facts were established. Mr. Baker's testimony shows the amount invested by appellant in its lines in the affected territory, particularly during the years since and including 1924; while Mr. Kirkbride's testimony establishes the adequacy of the track and track structures to carry the heaviest type of locomotive or other equipment owned or used by appellant. This same testimony likewise establishes that block signals and numerous other safety devices of approved modern type have been installed on every part of the affected main line.

There was no showing, or even suggestion, on the part of appellee that any portion of the track or structures in the affected territory would be overloaded or impaired by, or inadequate to permit, the operation of long trains. As fully explained by Mr. Kirkbride, the ability of track or bridges to sustain the weight of heavy locomotives is largely determined by the speed at which locomotives are operated, subject to consideration of the load upon each individual driving axle of the locomotive unit. The locotives now operated by appellant in the affected territory, particularly in freight service, have an average load per driving axle approximately equal to and, in some instances, greater than that of the heavier and larger types used elsewhere on the system. In so far as concerns speed, the strains and stresses imposed upon track and track structures by relatively light locomotives in high-speed passenger-train service are far more serious than those imposed by substantially heavier locomotives used in freight service and moving at the maximum speeds (45 miles per hour) permitted in freight-train operation. Furthermore, no freight or passenger cars, even including freight cars loaded to maximum capacity, impose any strains or stresses greater than those imposed by the locomotives hauling the trains; consequently the capacity of the track is measured by its capacity to withstand passenger locomotive usage.

J. B. Baker, R. 824-830, 837-839, 846-856; *Dyer*, R. 1115, 1117-1118; *Kirkbride*, R. 1140-1176.

Exhibits 110 to 114 (R. 2964-2974), 157 to 159 (R. 3031-3033).

This finding bears directly upon the question whether the lines in the affected territory are of sufficient strength to permit the operation of long trains, in the event the law's restrictions should be removed; i.e., whether the law imposes any real restriction upon appellant's operations, or whether they should be properly restricted regardless of the fixed limitation imposed by law. This finding, taken together with the preceding subdivisions hereof, shows that there is no limitation inherent in the present physical plant in Arizona which renders impossible or impracticable the commencement and continuance of long-train operation which, as set forth in the findings hereafter, has been followed by appellant on all parts of its system, other than Arizona, for more than 18 years last past, and was in fact followed upon a limited scale and for a brief period in the affected territory as well.

(c) DEFENDANT'S LINES IN NEVADA AND UTAH: DESCRIPTION: COMPARISON WITH ARIZONA LINES (R. 3896-3897).

For the purpose of showing the effects of the law, both as a purported safety measure, and as a regulation imposing burdens and interference on appellant's operations, numerous comparisons have been made between such operations in Arizona and the affected territory generally, and the operations in Nevada and Utah. To support these comparisons, appellant has shown that the operating and traffic conditions which prevail in Nevada and the adjoining territory are essentially similar to, or at least fairly comparable with those which prevail in the territory affected by the Arizona law.

Finding III(c) relates primarily to the operating conditions, as distinguished from the character of traffic handled, in Nevada and Utah. It shows that in that territory the ruling grades and curvatures are approximately the same, and in any event no more favorable, than in Arizona; and that there are no ruling grades encountered in Arizona which exceed those in Nevada. The main lines in Nevada and Utah, like those in Arizona, are constructed in accordance with the best modern standards, and well maintained and equipped throughout with block signals and other safety devices.

We invite especial attention to the profiles of the lines across Arizona: Exhibits 155, 309 and 310, which should be compared with the profiles of the lines across Nevada: Exhibits 156, 306, 307 and 308. Further comparisons showing the percentage of the mileage on which the grades exceed one per cent in relation to total mileage, in both Nevada and Arizona, and the curvatures and other principal characteristics as well, expressed in percentages of total main-line mileage, are set forth in the testimony. This showing establishes the essential similarity of the operating conditions, and particularly shows that in Nevada and Utah conditions are certainly no more favorable than in Arizona, and may properly be considered, in view of the severe winter climate, to be somewhat less so.

None of the testimony, either oral or statistical, referred to in support of this finding, was in any way challenged as to its accuracy, nor was there any question whatsoever of the qualifications of appellant's witnesses. The finding

is fully supported, and is germane and essential for the reasons stated.

Answer, Par. 2, Part III (R. 9).

Dyer, R. 1111; *Kirkbride*, R. 1135-1140, 1161-1163, 1167-1176, 1177-1178, 1182-1183, 2102-2105, 2185-2200.

Exhibits 110 (R. 2964), 155-159 (R. 3029-3033), 301, (R. 2097), 302 (R. 2101), 303 (R. 2102), 306-308 (R. 2188), 309-310 (R. 2210).

IV.

CHARACTER OF FREIGHT AND PASSENGER TRAFFIC HANDLED UPON DEFENDANT'S LINES IN ARIZONA AND ADJACENT TERRITORY: COMPARISON WITH NEVADA TRAFFIC (R. 3897-3901).

(a) PREDOMINANT INTERSTATE CHARACTER OF ARIZONA FREIGHT AND PASSENGER TRAFFIC (R. 3897-3898).

An outstanding fact in this case is that substantially all of the traffic handled across Arizona, and thus subjected to the interferences and burdens imposed by the law, is interstate; that is to say, it either originates at or is destined to points outside of Arizona. In fact, approximately two-thirds of such traffic appears to be "bridge" traffic: i.e., it has both origin and destination outside of the state.

Witness Masson's Exhibits 141 to 148 inclusive (R. 3917-3924), contain an analysis of the freight and passenger traffic handled by appellant in Arizona for various years

and groups of years, and in various classifications, up to and including the year 1939. Thus, Exhibit 143 contains an analysis of the freight traffic actually carried by appellant in Arizona for the years 1925 to 1939, inclusive, as measured in revenue freight ton miles; while Exhibit 147 contains a similar analysis of passenger traffic as measured in revenue passenger miles. A computation from Exhibit 143 shows that for the five years 1935 to 1939, inclusive, 92.74 per cent of the revenue freight ton miles related to interstate freight traffic; while a similar computation, from Exhibit 147, shows that 95.49 per cent of the revenue passenger miles in Arizona related to interstate passenger traffic. Exhibit 144 contains a more detailed analysis of the freight traffic carried in four typical years, 1925, 1929, 1938 and 1939; the segregation being made as between traffic originating without and terminating within the state, that originating within and terminating without the state, that passing through the state but having both origin and destination outside, and that which is wholly intrastate in character. In both the years 1938 and 1939, the traffic originating and terminating outside of the state, and passing through the state, exceeded 68 per cent of the total traffic. A similar analysis of passenger traffic is found on Exhibit 148, which shows that the so-called "bridge" traffic was, in both 1938 and 1939, more than 74 per cent of the total.

Exhibit 141 contains an analysis of freight revenue, associated with the handling of freight traffic within or across Arizona, the revenues on interstate shipments being allocated to the state in accordance with mileage prorate formula adopted and followed by the Arizona Cor-

poration Commission though not subscribed to by appellant as accurate. This formula, which allocates to Arizona the same proportion of the total revenues earned by an interstate shipment which the distance traveled in Arizona bears to the total distance traveled by the shipment, is inaccurate particularly in so far as bridge traffic is concerned, because it makes no allowance for originating or terminating services, but assumes that all mileage is entitled to the same proportion of earnings. Regardless of such inaccuracies, the allocation shows that in every year since 1912, more than 90 per cent of the total freight revenues within Arizona have accrued with respect to interstate traffic; for the 5-year period 1935-1939, the proportion was approximately 93 per cent. In the year 1939, moreover, as shown by Exhibit 142, the bridge traffic passing across Arizona was responsible for more than 64 per cent of the total freight revenue earned in the state; and the figure for 1939 is representative generally of the years since and including 1930. In so far as concerns passenger earnings, the results are similar. In the most recent five years, more than 95 per cent of the passenger earnings within Arizona have accrued with respect to interstate passenger traffic.

Masson, R. 1058-1078, 1225-1226, 1236-1239; *Sines*, R. 1368-1373.

Exhibits 167 (R. 3041), 170 (R. 3044), 189 (R. 3082), 190 (R. 3083).

There can be little doubt that every freight and passenger train upon the main lines in the affected territory is an interstate train, within the meaning of the definition

set forth in Finding I. It is noteworthy that there was no attempt, on the part of appellee, to challenge or contest this showing of the predominant interstate character of the Arizona traffic; nor has there been any contention that any trains operated upon appellant's main lines during any recent period, or at the present time, consist or have consisted exclusively of cars moving in intrastate commerce.

The finding responds to the allegations of paragraph 6 of Part III of the answer (R. 22-23), and is important and essential, because it establishes that the trains moving upon the lines in Arizona, which are affected and regulated by the law, are all interstate trains, and carry interstate traffic almost exclusively; in other words, that the law is a regulation of commerce which is almost entirely interstate in character.

(b) CHARACTER OF COMMODITIES TRANSPORTED: NEED FOR EXPEDITION (R. 3898-3900).

In paragraph 6 of Part III of the answer (R. 22-23), it is also alleged that a substantial portion of the interstate traffic handled across Arizona consists of perishable agricultural products, which must be so transported as to avoid delay in delivery at eastern market destinations, with consequent losses due to price fluctuations, and decay and deterioration en route.

The evidence shows that more than 120,000 carloads, or 46 per cent of the approximately 262,000 carloads of all kinds of freight, both interstate and intrastate, handled on appellant's lines in Arizona in 1939, consisted of

products of agriculture or livestock; that approximately 89,000 carloads consisted of fruits and vegetables, and other perishable agricultural products. In the same year, out of approximately 191,000 carloads handled by appellant in New Mexico, 109,500 consisted of products of agriculture or livestock, and 87,000 carloads of perishable agricultural products. The predominant direction of movement of such perishables is shown to be eastbound.

As showing further the importance of the perishable traffic in the affected territory, 59 per cent of the eastbound cars handled into El Paso by appellant during the five years ending in 1939 were loaded refrigerator cars, while about 53 per cent of the westward cars handled out of El Paso were empty refrigerator cars. Refrigerator cars are, as stated in this finding, designed and in nearly all cases used for the transportation of perishable traffic. While this count of refrigerator cars and other traffic was made at El Paso, the evidence leaves no doubt that a traffic analysis at that point shows with close accuracy the character of the traffic moving across Arizona, because there are no stations between El Paso and the Arizona-New Mexico line at which any substantial number of cars moving either eastward or westward would be received, delivered, or diverted.

The necessity is apparent for prompt handling of this perishable and livestock traffic, and as well of the manufactured products of high intrinsic value referred to in the first paragraph of the finding; and moreover, such necessity is demonstrated by uncontested testimony. There is equal necessity for the prompt return of empty refrig-

erator cars, moving westward to the producing areas, and of other empty equipment used in handling this traffic.

Sines, R. 67-68, 1368-1373; *Kirk*, R. 255-257; *Fertig*, R. 505-506; *Cartmill*, R. 982-983, 986-987; *Mahoney*, R. 1022-1024; *Dyer*, R. 1110-1111; *Masson*, R. 1225-1228, 1236-1239, 1726-1730; *G. C. Baker*, R. 1284-1287, 1456.

Exhibits 167 (R. 3041), 168 (R. 3042), 170 (R. 3044), 175 (R. 1284), 189 (R. 3082), 190 (R. 3083), 217 (R. 3204-3208), 218 (R. 3206-3207).

The purpose of the finding is to show that the interstate traffic which is subjected to the restrictions, delays, and regulations of the Train-Limit Law is of the type which requires speedy handling, and suffers most directly from such delay and interference; and thus to show that the law operates with particularly drastic effect upon the principal traffic handled in the affected territory.

(c) ARIZONA TRAFFIC COMPARED WITH TRAFFIC ACROSS NEVADA (pp. 20-21).

This finding is a companion to Finding IV(c), and responds also to the allegations contained in paragraph 6 of Part III of the answer (R. 22-23). It is based upon undisputed statistics, which show that the traffic handled upon appellant's lines across Nevada and Utah is similar in character, both in that it is predominantly interstate, and in its distribution as between perishable products and other types of freight, to the traffic in the affected territory.

It also appears that the volume of appellant's freight traffic in and across Arizona does not vary to any marked extent from the volume handled in and across Nevada. This is definitely shown by the comparisons of the total volume of the traffic, measured in car miles, in the States of Nevada and Arizona, which appear upon many of the exhibits: notably Exhibits 149, 150, 277, 279 and 280. Exhibit 277 shows that during the six-year period 1935-1940, there were about 859,500,000 freight-car miles accumulated in Nevada, and 828,000,000 accumulated in Arizona. In the 18-year period 1923-1940 there were 2,391,000,000 freight-car miles accumulated in Nevada, and 2,283,000,000 in Arizona. In 1940 there were 164,482,000 car miles accumulated in Nevada, and 155,909,000 in Arizona, a difference of about 5 per cent.

The analysis of traffic moving over appellant's lines into Ogden, Utah, eastward, and out of Ogden, westward, which appears in Exhibit 189, and as well the analysis of loaded and empty car miles made by Pacific Fruit Express Company refrigerator cars and other cars in the two states, which appears in Exhibit 190, indicate approximately the same distribution as between refrigerator-car traffic, empty-car movements, and other car traffic, in Nevada as in Arizona. Ogden is comparable to El Paso, in that appellant's principal main line across Nevada and northern Utah connects there with the lines of several other carriers, and a count of eastward and westward traffic can readily be made; moreover, there are few if any stations between Ogden and the Nevada-Utah line at which any considerable volume of traffic is diverted, received, or delivered by appellant. Just as in the case of El Paso, sub-

stantially all of the traffic moving over appellant's line west of Odgen in either direction is interstate traffic moving either from or to points in or beyond Nevada. The distribution of the Arizona and Nevada traffic as between refrigerator-car traffic and other types is in substantially the same proportions in both states.

Dyer, R. 1110-1111; *Masson*, R. 1228-1239, 1726-1729; *Sines*, R. 1368-1373, 1386-1387.

Exhibits 167 (R. 3041), 169 (R. 3043), 170 (R. 3044), 189 (R. 3082), 190 (R. 3083), 217 (R. 3204-3205), 219 (R. 3208-3209).

The purpose of this finding is like that of Finding IV(c); namely, it indicates that from the standpoint of the traffic handled, appellant's lines in Nevada can also properly be compared with the lines in the affected territory.

V.

THE TRAIN-LIMIT LAW: HISTORY AND TEXT (R. 3901-3902).

This finding reproduces without any material variation (except the addition of the reference to the most recent compilation of the Arizona Statutes) the allegations of the initial paragraphs of each of the two causes of action set forth in the complaint (R. 1-4). These allegations were expressly admitted in paragraph 1 of Part I (R. 5), and paragraph 1 of Part II (R. 6) of the answer. The finding was incorporated for the purpose of setting forth in full the text of the challenged statute, and in order that the findings as a whole might be a complete recital of all matters involved in the case.

VI.

RECENT IMPROVEMENTS IN DEFENDANT'S TRANSPORTATION PLANT, BOTH GENERALLY, AND IN THE TERRITORY AFFECTED BY THE LAW (R. 3902-3908).

(a) IMPROVEMENTS IN TRACK, ROADBED, BRIDGES AND OTHER FIXED STRUCTURES (R. 3902-3904).

This finding responds to that part of the allegations contained in section (a) of paragraph 3, Part III, of the answer (R. 9), which relates to the improvements in the track and fixed structures on appellant's lines in the affected territory, made since 1912 and particularly since 1920. The finding refers in detail to all of the various permanent improvements which have thus been made, such as: replacement of lighter rail by heavier sections; use of crushed rock and slag ballast in place of gravel ballast, and in greater quantity; constant renewal and replacement of ties, and use of better ties in greater number; repair, renewal and replacement of bridges; separation of grades, and construction of automatic warning signals at highway crossings; construction of double track, and of additional yard and terminal facilities; the installation of block signals and interlocking signal plants; and the acquisition, reconstruction, and improvement of the lines formerly owned by the Arizona Eastern and El Paso and Southwestern railroad companies.

Kirkbride, R. 1132-1133, 1155-1176; *Herbert*, R. 1540-1545.

Exhibits 157 (R. 3031), 158 (R. 3032), 159 (R. 3033), 200 (R. 3149), 201 (R. 3150).

This finding is in part predicated upon Exhibits 110 to 114, inclusive (R. 2964-2974), which present the detail of

the additional investment in track and fixed structures made since January 1, 1924. We call special attention to the fact that in the 16 years, 1924 to 1939, inclusive, more than $21,000,000 in new money was invested by appellant for permanent improvements to the roadbed and fixed structures in the territory between Yuma and El Paso, which figure does not include any moneys expended in acquiring the El Paso and Southwestern or Arizona Eastern properties. The net additional investment in Arizona alone, for permanent improvements to roadbed and fixed structures, during said 16-year period, was about $18,400,000.

J. B. Baker, R. 824-830, 837-839, 846-856.

The finding also reflects the detailed testimony of witness Kirkbride, appellant's Chief Engineer, as to the manner in which renewals, replacements and new construction have been carried on in the affected territory, and the present state of the appellant's fixed physical plant.

Finally, the finding includes reference to the fact that the sidings and passing tracks on appellant's lines in Arizona, in 1912, the year when the Train-Limit Law became effective, were not generally of greater length than just sufficient to accommodate a 70-car train of that day, with its engine and caboose. While, as stated in the finding, such sidings have been generally improved since 1912, by being relaid with heavier rail or in other ways, and there have been some changes at various stations, the sidings in Arizona at the present time, apart from those at the more important stations, are still generally not longer than approximately 70 car lengths, including engine and

caboose. Many such sidings will not accommodate a full 70-car train.

Dyer, R. 1105.
Exhibit 197 (R. 3114).

While it is not necessary to discuss the point in connection with this finding, it is worth while to point out that there has been no reason or incentive for appellant to extend its Arizona sidings beyond the lengths prevailing in 1912. Sidings are necessarily adjusted to the lengths of the trains which they are called upon to accommodate. To install additional siding capacity would involve useless and unnecessary expense. It cannot properly be argued, however, that appellant has in any way neglected a desirable improvement in its fixed plant in Arizona, by having failed to extend siding capacities beyond those necessary for 70-car trains; nor can it be argued that appellant would be unable to operate long trains even if the restrictions of the law were removed. If the law is to be observed, as has been the consistent course of appellant throughout the years since 1912 (except for the period of limited long-train operation in 1940, and since 1942, under authority of Service Order 85), extensions of sidings would be a useless and unnecessary investment. On the other hand, a limited long-train operation is practicable, as was demonstrated in April, 1940, even with present siding capacity. Moreover, as stated elsewhere in the findings and fully shown by undisputed testimony, the siding extensions necessary to long-train operation on a substantial and virtually unlimited scale are wholly prac-

ticable, and can be accomplished by a relatively moderate investment.

See *Findings* IX(a) and (b): R. 3947-3950.

Finding VI(a) responds to an essential allegation of the affirmative defense, as to which there was no opposing testimony offered by appellee. In fact, to the extent that the subject-matter was treated at all in the testimony of appellee's witnesses, that showing tends to confirm the facts set forth in the finding.

(b) IMPROVEMENTS IN LOCOMOTIVES, CARS AND EQUIPMENT (R. 3904-3907).

Finding VI(b) corresponds to the preceding finding, in that it sets forth the improvements in the motive power and equipment used in the affected territory, corresponding to the improvements in fixed property which are the subject of the preceding finding. It will be noted that the finding also states that the same types of equipment are in use upon appellant's lines in Nevada and Utah.

This finding responds to the issues tendered by sections (a) and (b) of paragraph 3 of Part III of the answer (R. 9-10).

As to the locomotives in service or available for service in the affected territory, the testimony shows the consistent improvement of appellant's motive power, and the present ownership and use of modern-type locomotives, fully adequate to handle long trains with speed, economy, efficiency, and safety. These locomotives are equipped with the various devices, referred to in the finding, which promote economy of operation while permitting the attain-

ment of greater speeds, accompanied by better control of trains while on the road. The locomotives in use in the affected territory are among the latest and most modern types owned by appellant; and are the same types which have recently been and presently are in use in Nevada, as well as in those adjacent portions of California and New Mexico where the traffic handled and the service rendered is substantially the same as in Arizona. These locomotives have demonstrated, over several years of use, that they are fully capable of handling and controlling appellant's long trains, including both loaded and empty cars, at the speeds made necessary by present-day schedule requirements, in territory not essentially different from Arizona.

The amount expended by appellant in acquiring this new and more efficient motive power is not a matter of dispute. The detail of the expenditures made since 1922 in the acquisition of new locomotives, pursuant to authority granted by the Interstate Commerce Commission under Section 20a of Part I of the Interstate Commerce Act, is shown on Exhibit 7; while the dates and citations of the Commission's orders in connection with each such authority appear on Exhibit 174. In each such proceeding it was made to appear and was found, in conformity with Section 20a, that the expenditures proposed were for a purpose necessary to the conduct of appellant's obligations as a common carrier and consistent with the performance of that obligation, and would reasonably be necessary in furtherance of such performance of appellant's common-carrier duty. In each proceeding the character of the locomotives to be purchased, including the power which they would develop and the amount of the tonnage which they

would haul, were all expressly set forth in the applications, and generally referred to in the Commission's decisions. It was particularly made to appear, at least as to the more recent acquisitions of heavier locomotive types, that such locomotives were individually capable of hauling many more than 70 freight cars in ordinary operation, and thus that they were being acquired expressly for the purpose of operating or continuing the operation of long trains, in accordance with appellant's established practice. The Commission, by giving the express authority required by law for the acquisition of these locomotives has thus approved, authorized, and encouraged the long-train operating method followed by appellant on all parts of its system except in the affected territory.

Russell, R. 97-112; *Masson*, R. 1261-1264; *Sines*, R. 1350-1354, 1710-1711, 2285-2286; *Burke*, R. 1609-1611; *F. P. McDonald*, R. 1612-1614; *Fifield*, R. 2792, 2799, 2800-2801, 2806; *Menzies*, R. 2815-2816.

Exhibits 5 (R. 2855), 6 (R. 2856), 7 (R. 2857), 174 (R. 3064), 183 (R. 3075), 212 (R. 3196).

That portion of the finding which relates to improvements in the freight and passenger car equipment used in the affected territory and elsewhere is equally important, in that it shows the greater factor of safety (from the standpoint of the strength and other characteristics of the freight and passenger cars in service) introduced into appellant's train operations, side by side with the adoption and carrying out of the long-train program.

Improvements in freight-car construction have included the complete elimination of the wooden-underframe car, insofar as through or interchange service is concerned. This restriction means that such wooden cars cannot be loaded with freight to be interchanged, without transfer of the lading, at El Paso or Tucumcari or any other interchange point. In a practical sense, wooden-underframe cars are no longer used in main-line service.

The arch-bar type of truck, which appears to have been a point of weakness and thus responsible for accidents involving freight cars in earlier years, has likewise been eliminated; all cars in use in interchange service in the affected territory are entirely equipped with trucks having cast-steel side-frames. Another important improvement is the elimination of the older double-plate type of wheel; single-plate cast-iron wheels are now in universal use upon all freight equipment in the affected territory.

Other improvements have included the use of heavier types of graduating springs in the triple valves, described by one of appellee's witnesses (*Cooper*, R. 2442) as one of the best improvements ever accomplished. The effect of this replacement, which is now complete as to all cars in interchange service, has been to eliminate in a practical sense the so-called "quick-action" triple valve, which in the past was a common source of unintended ("undesired") emergency action. A further improvement, now in progress, is the adoption of the improved type of freight-brake valve known as the "AB" valve. This valve is now standard upon all cars built new during the last ten years, and by express requirement of the Interstate Commerce Com-

mission will shortly be required upon *all* cars used in revenue freight service.

A further important improvement in freight-car equipment has been the widespread use of the modern friction draft gear, in place of the older-type tandem-spring draft gear. All refrigerator cars, and more than 80 per cent of all of the other freight cars owned by appellant and used in interchange service, are equipped with friction draft gears.

The finding states, and the evidence likewise establishes, that substantial improvements have been made in passenger-car equipment. Among such improvements have been the complete elimination of wooden passenger cars; the substantial reconstruction and improvement of the braking appliances; the strengthening, and improvement otherwise, of the couplers, draft gears, and draft riggings; and the installation of many other devices, shown in detail in the evidence, all contributing to the safety and comfort of the traveling public and the employes on the passenger trains, and greater ease, safety and economy of passenger-train operation.

Leriche, R. 72, 78, 80-94, 113; *Parke*, R. 787-798, 805-824; *Cartmill*, R. 989-1012; *Browning*, R. 1557-1575; *Bohnstengel*, R. 1673-1706; *Barker*, R. 1866-1868.

Exhibits 2 to 4 (R. 2852-2854), 107 to 109 (R. 2960-2963), 135 (R. 3002), 136 (R. 3003-3005), 204 (R. 3153-3180), 210 (R. 3194), 247 (R. 3253), 396 (R. 3572-3577).

The purpose of this finding is to sustain the important allegations above referred to, which are incorporated in the affirmative defense. The annotations show that there is no real conflict in the testimony. The finding is directly material and essential, because it serves to show that the equipment available to appellant, in actual use in its trains in the affected territory as well as in Nevada and elsewhere upon its system, is of the same adequacy to permit long-train operation, as the roadway, track, and fixed structures described in Finding VI (a); that the arbitrary restriction created by the law is unnecessary, and defeats the very purpose for which were incurred the substantial outlays made by appellant, and expressly authorized by the Interstate Commerce Commission; and thus, to a very large extent, unnecessarily deprives appellant of the use and usefulness of such property.

At the risk of repetition, we emphasize again the initial sentence of Finding VI(b), and in this connection refer also to the initial sentence of Finding VI(a). These sentences call attention to the fact that the improvements, set forth in detail in each of these findings, have taken place during the years since 1912, when the Train-Limit Law was enacted, and more especially since 1923. We believe that they were incorporated in the findings for the particular purpose of calling attention to the very great changes in the railroad properties, both fixed and movable, operated by appellant in the affected territory. No principle is more universally recognized than that which declares that a rule or regulation directed to a particular set of circumstances, and which might be reasonable in the light of the facts then existing, may become wholly

unreasonable, and necessarily subject to change or rescission, when the essential circumstances themselves are changed. Even though it be argued that the Train-Limit Law had some ostensible warrant as a safety measure, in the light of appellant's plant, equipment, and operating methods in Arizona in 1912, the extensive and virtually complete redesign and reconstruction of that plant and equipment in the intervening 29 years, accompanied (as shown in succeeding findings) by equally extensive revisions of operating methods, creates at least a strong presumption, if it does not fully establish, that the Train-Limit Law is outmoded and obsolete, addressed to a state of affairs which no longer exists, and therefore wholly unreasonable and unnecessary as applied to present-day conditions.

(c) PURPOSE OF THE IMPROVEMENTS MADE BY DEFENDANT: ADEQUACY OF DEFENDANT'S PRESENT TRACK, STRUCTURES, AND EQUIPMENT TO PERMIT OPERATION OF LONG TRAINS (R. 3907-3908).

This paragraph of the findings responds very largely to the allegations in the concluding sentence of section (a) and also the concluding sentence of section (c) of paragraph 3 of Part III of the answer (R. 10-11).

There can be no question, in the light of the testimony of appellant's witnesses, particularly Messrs. Dyer and Kirkbride, that the heavy expenditures for the improvement of appellant's road and equipment were undertaken for the primary purpose, as stated in the finding, of enabling the appellant's railroad properties to be operated with the greatest possible safety, efficiency, and economy,

and in furtherance of the proper discharge of its public duty as a common carrier. Appellee has never contended that such was not the purpose, or that any other purpose was intended.

The finding refers to the expenditures undertaken by appellant, particularly those since 1923, as being part of the general program of betterment of the railroad transportation plant commenced in that year by United States railroads generally. The testimony of Dr. Parmelee establishes that the general program was agreed upon and instituted in 1923, and that appellant participated therein.

Parmelee, R. 186-190.

The careful inspection and maintenance of the track, bridges, and other structures in the affected territory, and their present adequacy to permit the operation of the heaviest locomotives and trains owned or used by appellant, are matters of fact as to which there is no conflict. As to the locomotives, it is shown that those presently in use in that territory are fully adequate to handle long freight and passenger trains; moreover, there are available heavier and more powerful locomotives which will handle such trains with even greater efficiency and economy. There is no question as to the adequacy, from the standpoint of strength and construction, and the devices and appliances with which they are equipped, of the cars operated or to be operated in appellant's trains. In short, long-train operation, with equipment which appellant now has in use or available for use in the affected territory, and upon the lines in that territory in their present condition, is completely practicable. Climatic con-

ditions, and all other conditions affecting train operation, are favorable, or do not in any event constitute a limiting factor. The intention of appellant to operate long trains at once if relieved of the restrictions, to the extent that present siding capacities permit, and to increase siding capacities in order to develop the long-train program more fully, is likewise fully shown.

Dyer, R. 1115-1117.

The final and convincing demonstration of the practicability of long-train operation in Arizona is set forth in the concluding paragraph, which refers to the experience gained during the months of March and April, 1940, when appellant operated 62 long passenger trains and more than 302 long freight trains in Arizona, without any sacrifice of efficiency, or schedule requirements, or safety of operation; in fact, as is stated more fully in subsequent findings, with substantially increased efficiency and economy, and without any casualty or accident which could be in any way ascribed to or associated with train length.

VII.

DEFENDANT'S METHODS OF OPERATION, PAST AND PRESENT (R. 3909-3934).

Finding VII embodies a description of the methods of operation, past and present, followed by appellant upon its system generally, with particular reference to operating methods and the results of such operations in the affected territory.

The finding describes, first, the operating subdivisions, the runs of crews and locomotives, and the general topics

of operating rules and inspections, and then deals with the subject of train lengths, and the development of the long-train program upon the system generally and in the various states other than Arizona. Appellant's freight-train schedules, both past and present, are also referred to in some detail. Finally, there are set forth the effects of the long-train program upon the efficiency and economy of operations, as reflected in the operating statistics, regularly maintained by appellant, and brought from appellant's permanent records into the testimony. The finding thus deals with the issues specifically tendered in section (d) of paragraph 3 of Part III of the answer (R. 11-12) and the first sentence of section (g) of the same paragraph (R. 14).

(a) OPERATING SUBDIVISIONS: RUNS OF CREWS AND LOCOMOTIVES: OPERATING RULES: INSPECTIONS (R. 3909-3915).

(1) Operating divisions and subdivisions (R. 3909-3911):

The first subdivision of Finding VII(a) is essentially preliminary to the later paragraphs. This paragraph defines the divisions and subdivisions in the affected territory, and also in Nevada and Utah, and names the stations designated as freight-train terminals. The operations at those terminals are likewise briefly described, as well as the manner in which the trains are operated. The finding is based upon the undisputed testimony of the several witnesses for appellant who dealt with this subject-matter.

Sines, R. 66-69, 1360-1363, 1384-1385, 1519-1526, 1718, 1721-1722, 1795-1797, 2283-2284; *Kirkbride*, R. 1124-1125; *G. C. Baker*, R. 1285-1286, 1305-1306, 1455-1470; *Herrell*, R. 1487-1488, 1492-1497.

(2) Runs of crews and locomotives (R. 3911-3912):

Subdivision 2 is a continuation of the general description of the operations in the affected territory, containing a brief reference to the customary runs of crews and locomotives in both freight and passenger service.

This paragraph is complementary, in a sense, to paragraph (1), and has been incorporated in the findings with the same purposes in mind. It is also based upon undisputed testimony, principally that of Mr. Sines, as supplemented by Chief Dispatchers Baker and Herrell.

Sines, R. 66-69, 1411-1420, 1423-1424, 1721-1722, 1768, 2284; *Baker*, R. 1456-1463; *Herrell*, R. 1489-1490.

(3) Operating rules (R. 3912-3913):

The general subject of operating rules is discussed at length in the record, particularly in the examination of certain of appellee's witnesses. Paragraph (3) of Finding VII(a) condenses that testimony into one rather brief paragraph, which states that such rules exist, and are codified into the two printed books referred to by name in the text of the finding. It will be noted that the finding also expressly states that these rules apply to operations in all parts of the system, including both the affected territory and the lines in Nevada and Utah.

Dyer, R. 1109-1110; *Cheek*, R. 2482; *Durnil*, R. 2384; *Stevenson*, R. 2490; *Fifield*, R. 2808-2811; *Menzies*, R. 2820-2824.

Exhibits 319, 320 (R. 2287).

This finding is essential, because it deals with a subject matter important to the case from the standpoint of both

parties. The finding does not contain any statement as to which there is any conflict of testimony or opinion. We call especial attention to the specific statement therein to the effect that the rules under which appellant's operations are carried on are complete and adequate, and insure safe operations, *provided that they are fully observed and complied with.*

(4) Inspections (R. 3913-3914):

This paragraph deals rather fully with the matter of car inspections, covering the purpose and character thereof; the places where made; the employes by whom made; the frequency; and the results which follow.

The subject of inspections of cars was dealt with at some length in appellant's testimony, and was also mentioned, somewhat more briefly, by certain of appellee's witnesses. Appellant's witnesses also referred to and produced the code promulgated by the mechanical division of the Association of American Railroads, of which association appellant is a member; and established that appellant, by reason of its membership, of necessity complies with and conforms to the code. Testimony was also offered through Mr. L. E. Cartmill, General Superintendent of the Car Department of the Pacific Fruit Express Company, describing in detail the additional and separate inspections given to refrigerator cars. These refrigerator cars form approximately 50 per cent of the consist of the through freight trains operating over the appellant's lines in both the affected territory and across Nevada.

Cartmill, R. 998-1003; *Browning*, R. 1557-1569.
Exhibits 137 (R. 3006), 204 (R. 3153-3189).

As the finding states, there are frequent inspections of trains and cars by car forces at terminals and interchange points, and by train crews at terminals, and while trains are on the road between terminals. The result of such inspections, as made by trainmen upon long and short trains in that portion of the affected territory between Lordsburg and El Paso, during the six months' period January to June, inclusive, 1940, was made the subject of special and separate study: Exhibit 397 (R. 3578). That exhibit demonstrates that such inspections are effective, on both long and short trains, to discover defects of equipment and other conditions which might cause delay or accident, or otherwise interfere with train movements.

Sines, R. 1423-1425, 1758-1759; *Reid*, R. 1596-1600, 1603-1604; *Burke*, R. 1607-1609, 1611; *F. P. McDonald*, R. 1614-1616.

See also *Finding* XIII(d) (R. 4026-4029).

This paragraph is thus a condensed summary of the pertinent testimony upon this subject, which, however, avoids any disputed or controverted matters. It is based upon competent and unchallenged testimony, and reflects all of the essentials thereof. The finding is necessary, to present a fair and complete description of train operations in the affected territory and elsewhere upon the system, and of the factors which enter into the safety of those operations, and thus, in particular, to afford a foundation for subsequent findings dealing more directly with the subject of safety.

(5) Similarity of operating methods, rules, records, etc., on defendant's lines in Nevada and Utah to those in the affected territory (R. 3914-3915).

This paragraph is similar in purpose to subparagraph (c) of Finding III and subparagraph (c) of Finding IV; in that it sets forth that the operating methods, rules, and records relating to operations in Nevada and Arizona are substantially identical; that the same system officials have jurisdiction over operations in both states; and that the full-crew laws of both states, insofar as they concern appellant's train operations, are also practically the same. The finding likewise emphasizes that the same equipment is used interchangeably in both the affected territory, and Nevada and Utah.

We call particular attention to that portion of the finding which states that the records maintained by appellant, and the numerous statistical and other reports required by regulatory commissions, are developed, maintained and rendered in accordance with substantially identical rules and standards. It follows that operating and other statistics relating to operations in the affected territory or in Arizona, on the one hand, and in Nevada and Utah, or in the State of Nevada alone, on the other, are fully and properly comparable, and reflect operating results upon identical bases.

Dyer, R. 1108-1119; *Masson*, R. 1236-1239; *Sines*, R. 61-62, 1354-1355, 1708-1711, 3145-3149.

Exhibits 8 (R. 114), 9 (R. 115-116), 170 (R. 3044), 184 (R. 3076), 191 (R. 3084), 195 (R. 3107-3112), 212 (R. 3196), 260 (R. 3272), 305 (R. 3430).

This finding is likewise essential, because it shows that a proper and adequate—indeed, a complete—foundation has been laid, for reference to and reliance upon the numerous comparisons between operations in the affected territory and those in Nevada and Utah, which afford the basis for a number of important subsequent findings.

(b) LENGTHS OF DEFENDANT'S TRAINS (R. 3915-3920).

(1) Train lengths on the system generally (R. 3915-3916):

In section (d) of paragraph 3 of Part III of the answer (R. 11-12) it is alleged that the operation of through long freight trains is a common practice on main trunk lines throughout the United States, including appellant's lines; and in section (e) of the same paragraph (R. 12) it is stated that the operation of long freight trains is a general practice on appellant's main lines, and likewise on the lines of its competitors and connections, except in Arizona. In section (a) of paragraph 4 of Part III (R. 16-17) somewhat similar allegations are made as to passenger-train operations.

Subparagraph (1) of Finding VII(b) responds in part to the issues thus tendered. It sets forth the date when long freight and passenger-train operation was first undertaken on a substantial scale; the continuance of the practice ever since; the fact that it prevails on all the system, except in Arizona and the adjacent affected territory; that it has resulted in a substantial increase in the average length of all trains operated; and finally presents figures showing the increases in average train lengths, and the percentage of long trains to all freight trains operated during a recent representative period, upon the

principal main-line districts in the several states, other than Arizona, where appellant operates.

Dyer, R. 1106-1107, 1115, 1119-1120; *Masson*, R. 1078-1082; *Herbert*, R. 1315-1316, 1324-1325, 1337-1339; *Sines*, R. 1359-1366, 1707-1708; *Fifield*, R. 2784-2786, 2805-2806.

Exhibits 149 (R. 3025), 150 (R. 3026), 162 (R. 3036), 177-180 (R. 3066-3072), 185-188 (3077-3081), 211 (R. 3195).

The finding is based upon unchallenged testimony. The showing is very complete, having been compiled from appellant's original records. The finding is essential, because it has direct bearing upon the point that enforcement of the law has prevented and continues to prevent the adoption, in the affected territory, of an operating method which has been successfully followed for many years last past upon all other parts of the system; and, as shown by subsequent findings, particularly Findings VII(d) and XII, with constantly improving efficiency, economy, and safety.

(2) Train lengths in Arizona, past and present: Comparison with other portions of the system, and with the system as a whole (R. 3917-3920):

The purpose of this subparagraph of Finding VII(b) is to set forth the extent of long-train operations in Arizona during the period immediately preceding the effective date of the law, and to show how the law has operated to keep the average train lengths in Arizona at a fairly constant figure, throughout all the period since 1912. The

finding sets forth comparisons between Arizona and Nevada average freight-train lengths, and also compares Arizona and Nevada average train lengths with those which have developed on the system as a whole, and on the main lines of the Tucson and Salt Lake Divisions. This finding thus really carries forward the history of long-train operations on appellant's system, set forth in part in subparagraph (1).

The effect of the long-train program in Nevada, in enabling appellant to move the traffic with a substantially less number of freight trains, by comparison with Arizona, is also set forth. In the four years, 1922-1925, inclusive, the actual traffic handled in Nevada, expressed in car miles, was approximately 420,673,000, or about 11.2 per cent more than was handled in Arizona during the same period (the Arizona figure having been 378,372,000). To move these car miles in Nevada, appellant operated a total of 7,924,000 train miles, or about 14.0 per cent more than the 6,953,000 train miles which were operated in Arizona in the same period for the purpose of handling the Arizona traffic. During the years 1922-1925 the total volume of traffic in Nevada thus exceeded the total volume of traffic in Arizona by a margin slightly lower than the percentage by which the total number of trains run in Nevada (expressed in train miles produced) exceeded the corresponding figure for Arizona.

These results were obtained before the initiation of the long-train program on a substantial scale in Nevada. They may therefore be compared with results obtained during the most recent typical four-year period for which statistics were available at the time the testimony was

received: the years 1936-1939. During that period appellant produced in Nevada 564,256,000 freight-car miles, or approximately 3.9 per cent *more* than the 543,210,000 which were produced in the same period in Arizona. It handled the Nevada traffic with 7,397,000 train miles, or 26.7 per cent *less* than the 10,086,000 train miles which were produced in Arizona for the purpose of handling the smaller volume of the Arizona traffic. It should be noted, also, that in the four years, 1936-1939, appellant handled in Nevada a volume of traffic 34.1 per cent greater than in the four years 1922-1925, but actually produced 6.7 per cent fewer train miles in so doing.

The effect of the Train-Limit Law in requiring the operation of additional and unnecessary trains is further developed by the comparison between the Tucson and Salt Lake Divisions, set forth in the finding. If appellant had disregarded the Train-Limit Law, and thereby obtained on the Tucson Division the same average train lengths as prevailed on the Salt Lake Division during the fifteen years 1925-1939, it could have saved 6,325,000 train miles; i.e., some 32.7 per cent *more* train miles were produced than would have been necessary if the long-train practice had prevailed. For the one year 1938, approximately 565,000 train miles, or 37.7 per cent of the total produced on the Tucson Division, were excessive and unnecessary, and could and would have been eliminated by long-train operation.

This subfinding concludes with the statement that long-train operation is entirely practicable in Arizona, subject only to certain siding extensions and other comparatively minor alterations of the physical plant, and the asssign-

ment of locomotives of the larger types now in use upon other parts of appellant's system. This finding is based upon undisputed testimony, as to which appellee offered no challenge.

Masson, R. 1078-1082; *Dyer*, 1106-1108, 1114-1115, 1117-1118; *Herbert*, R. 1234-1236, 1343-1345; *Sines*, R. 1346-1355, 1710-1714, 1831-1832.

Exhibits 149 (R. 3025), 150 (R. 3026), 180-183 (R. 3072-3075), 213 (R. 3197).

(c) REDUCTIONS IN SCHEDULES OF FREIGHT TRAINS (R. 3920-3924).

In sections (d) and (e) of paragraph 3 of Part III of the answer (R. 11-12) it is alleged in general terms that freight is transported between all parts of the United States upon dependable schedules, and in long trains, except that such trains are not operated in Arizona and the adjacent affected territory; that such schedules are one-half to one-third faster than prevailed prior to 1924, and that such long-train operation does not retard or delay such freight traffic, but on the contrary expedites it materially, and promotes and makes possible its early delivery.

Finding VII(c) describes the prior and present schedules in effect in both the affected territory and likewise in Nevada and Utah, and thus corresponds directly to such allegations. The finding explains how present-day schedules for eastbound perishable freight have been worked out, based upon definite departure hours and times en route from specified concentration points; together with the provisions for "run-off" time, made necessary

because, *first*, cars containing perishable freight and intended to move under these schedules cannot all arrive at the concentration points, and be made ready for departure at the same time each day; *second*, when more than one train is to leave a concentration point with cars moving on schedule, not all of the trains of the same day can leave at the same moment. In practice, therefore, those cars and trains which leave after the initial scheduled departure hour on a particular day are so operated as to make up ("run off") the time interval prior to their departure, so that they arrive in Chicago or other eastern markets upon a parity with all other shipments leaving upon the same day, and moving under the same schedule.

G. C. Baker, R. 1285-1295.
Exhibit 176 (R. 3065).

The finding contains a history of the reductions in the schedules, both eastbound for perishable freight, and westbound for manifest and similar freight; and shows that the present-day schedules are very much faster than those in effect previously, particularly prior to about the year 1924. In 1924, for example, the basic eastward schedule from California concentration points to Chicago was 154 hours over-all, with no provision for run-off time; today, the schedule contemplates an over-all time of 139 hours and 30 minutes, but also provides for 16 hours of run-off time, so that the net elapsed time is 123 hours and 30 minutes. This represents a reduction of 31 hours and 30 minutes in net time, as compared to 1924, or a net reduction of more than 20 per cent. The history of the westbound schedules shows a reduction from an over-all time of 226 hours, which existed up to 1926, to a present-day

over-all time of 109 hours: a reduction of substantially more than 50 per cent. The schedules applying from northern California, and in general from all Pacific Coast points served by the routes through Nevada and Arizona, are upon the same bases.

G. C. Baker, R. 1296-1302.

Although the faster schedules necessarily import greater difficulty in achieving and maintaining on-time performance, the record indicates that there has been no failure in this regard. Nevertheless, the schedule performance of those trains directly affected by and subject to the restrictions of the law has not been as satisfactory as in the case of those trains where the law's effects are either wholly absent or somewhat less in proportion. Thus, for those eastbound trains or blocks which moved from Colton, California, to El Paso, in 1939, and were directly affected by the law for the entire distance between Yuma and El Paso, the on-time percentage was 82.5. For those trains or blocks which moved from Colton to Tucumcari, New Mexico, and were unaffected by the law between El Paso and Tucumcari, the on-time percentage was 94.8 per cent. On the Nevada route, for traffic out of Roseville, California, a concentration point corresponding to Colton (and where the movement is entirely free of any train limit), the on-time percentage at Ogden was 88.8 per cent. For those westbound trains which moved across Arizona, the on-time performance at Los Angeles was 90.7 per cent; but for the westbound trains moving across the Nevada route to San Francisco, the on-time performance was 95.4 per cent.

G. C. Baker, R. 1478-1482.

The fact that freight-train schedules applying to transcontinental movements have been so substantially reduced, side by side with the institution and development of the long-train program, is no mere coincidence. The reductions in schedules are not merely theoretical. The participating carriers hold these schedules out to the general public as an index of expected performance, and are subject to claims if loss of market or spoilage should result from a schedule failure for which a carrier is responsible. In fact, as the percentages just recited show, the schedule reductions have been accompanied by operation of the scheduled trains in substantial conformity with the guaranteed schedules; and it is noteworthy that as the influence of the Train-Limit Law is absent, or is reduced in proportion to the total transportation service performed, the percentage of schedule performance becomes better. It will be borne in mind that the adoption of the long-train program, in connection with transcontinental schedules via Arizona, is not completely prevented by the Arizona law. That statute affects these transcontinental movements principally over the district between Yuma and El Paso; but once the traffic has passed through El Paso or Yuma, long-train operation is again possible except to the extent that Oklahoma's train-limit law, effective since 1941, imposes a barrier; and, as established by the testimony of witnesses representing the various carriers with which appellant connects, such long-train operation, particularly in the handling of through traffic, both perishable and non-perishable, is the customary, standard, and regular practice.

The finding is an accurate summary of the undisputed testimony of record, and responds directly to allegations of appellant's affirmative defense.

(d) EFFECT OF THE LONG-TRAIN PROGRAM UPON THE EFFICIENCY AND ECONOMY OF DEFENDANT'S TRAIN OPERATIONS (R. 3924-3934).

(1) As to the system generally (R. 3924-3927):

In Section (g) of paragraph of Part III of the answer (R. 14-15) it is alleged that appellant's compliance with the Train-Limit Law results and has resulted in greatly reducing the efficiency and economy of its freight-train operations in the affected territory. Finding VIII(d) responds to the issue thus presented.

As to the system generally, in Finding VII(b) it is set forth that the average length of appellant's freight trains on the entire system has increased from 42.4 cars per train, exclusive of caboose, in 1922, to 51.7 cars in 1934, and 53.6 cars in 1939. In Finding VII(d) are set forth the improvements in efficiency and economy of railroad operation on appellant's system, which have accompanied this increase in average train lengths, and have been experienced side by side with the adoption of long-train operation upon all parts of the system, except in Arizona and the adjacent territory affected by the law.

An important index of operating efficiency, which particularly reveals the effect of long-train operation, is found in the average speed of all freight trains. The importance of this index and also of the indices of gross ton miles and net ton miles per freight-train hour, as

reflecting efficiency, was recognized by this Court in the *Retirement Act Case: Railroad Retirement Board v. Alton R. Co., et al.* (1935), 295 U.S. 330 (366); 79 L.ed. 1468 (1485).

The term "average train speed", as used in Finding VII(b) and elsewhere, means the average speed of trains while on the road between terminals, including all stops en route, but not including time spent in terminals. The average speed of appellant's main-line freight trains increased from 11.2 miles per hour in 1922 to 17.8 miles per hour in 1939; an improvement of 58.9 per cent. It is clear, from this fact alone, that the long-train program has not resulted in the slowing down of the movement of main-line freight traffic on the system; on the contrary, there has been an acceleration amounting to almost 60 per cent.

Herbert, R. 1338, 1340-1341.
Exhibit 180 (R. 3072).

As stated above, the "average gross ton miles per freight-train hour" was also recognized by this Court as an important index of efficiency of operation. This index is determined by first multiplying the total tonnage transported (which includes the weight of the cars and their contents, but not the weight of the locomotives) by the miles over which it is moved. The product represents the total gross ton miles produced. This total is then divided by the total number of hours spent on the road by the freight trains whose total gross ton miles were determined. The quotient represents the average performance, in gross ton miles per freight-train hour. This index

thus reflects both the speed and the loading of the trains, and provides a test of both factors: the higher the figure, the better the relative performance. For appellant's system, and considering main-line freight trains only, the total of gross ton miles per freight-train hour was 20,727 in 1923; and increased to 41,886 in 1939: an improvement of 102.1 per cent, or more than double. These figures simply mean that, coincident with the adoption and development of the long-train program on the system, appellant was enabled to and did move more tonnage, for greater distances, during each freight-train hour on the average: in other words, both heavier train loading, and higher train speeds were made possible and were accomplished. It should be borne in mind that the year 1923 was prior to the adoption of the long-train program, whereas 1939 was a year of general long-train operation.

Masson, R. 1207-1209.
Exhibits 162 (R. 3036), 193 (R. 3105).

A corresponding index is afforded by net ton miles per freight-train hour. This figure takes into account only the net weight of the lading transported, and does not include the weight of locomotives, or of cars exclusive of their contents. In 1922, this index, for all freight trains on the system, both main and branch, was 7,258; it increased to 12,490 in 1939: an improvement of 72.1 per cent. That is, the combined effect of greater train loading, and greater train speeds, which accompanied the adoption of the long-train program, thus enabled appellant to obtain more than 72 per cent greater efficiency in the movement of the

freight, considered separately from the equipment in which it was carried.

Masson, R. 1204.
Exhibit 162 (R. 3036).

Another important index of operating efficiency is found in the relationship between fuel consumed and traffic moved. This index is sometimes expressed in total of performance, measured in gross ton miles, for each ton of fuel consumed. In the case of a railroad such as appellant, which uses comparatively little coal, the consumption of fuel oil is measured in units equivalent to pounds of coal, the total equivalent pounds of coal being divided into the total gross ton miles produced in order to obtain the average figure. For all freight trains, both main and branch, on the system, the average gross ton miles per ton of fuel in 1922 was 11,405; in 1939 it was 17,318; an improvement of 51.8 per cent. This result simply means that with longer and heavier trains; and despite greater train speeds, nearly 52 per cent more actual performance was obtained for each ton of fuel consumed in freight-train operation.

Exhibit 162 (R. 3036).

The relationship between the total of operating expenses, and the revenue traffic handled, likewise affords an important index, particularly in comparing the over-all economy of operations year by year. The lower the average cost, the better the performance; i.e., the greater the efficiency. For the system, the average cost per thousand revenue ton miles, for all operating expenses, declined from $11.10 in 1922, to $7.05 in 1939; an improvement of

36.5 per cent. The average for the years 1922-1925 (the period immediately preceding the general adoption of long-train operation) was $9.94; the average for the four years 1936-1939 was $7.15: an improvement of 28.1 per cent.

Exhibit 151 (R. 3027).

The index last referred to, which includes all operating expenses, takes into account those costs of maintenance and general overhead which enter into costs of operation. The finding also includes reference to the average cost per thousand revenue ton miles for transportation expenses only. These expenses include those directly associated with freight-train operations, but do not include costs of maintenance of way, or other general expenses not directly incident to the running of trains. For the system, the 1922 figure of average cost per thousand revenue ton miles was $5.47; for 1939 the corresponding figure was $3.82: an improvement of 43.2 per cent. For the four years 1922-1925 the system figure was $5.03, and for the four years 1936-1939 $3.95: an improvement of 21.5 per cent. These figures simply mean that coincident with the adoption and development of the long-train program on the system, there was a reduction in the direct expense of freight-train operations of more than 20 per cent.

Exhibit 151 (R. 3027).

A further important index, particularly for the purpose of making comparisons between operating costs for different periods, on the system or on the same division, or as between different portions of the system, is afforded by the so-called selected direct operating expenses. These

selected expenses include fuel costs, trainmen's and enginemen's wages, enginehouse expenses, other locomotive supplies, and train supplies and expenses; and thus include all of the major items directly associated with the movement of trains. They exclude all indirect items of expense, such as wages of yard employes, maintenance costs, wages and expenses of supervisory employes and officers, and the like. The finding shows that the average cost per thousand gross ton miles, for these selected direct expenses, for all freight trains operated on the system, decreased from 93.4 cents in 1924, to 63.6 cents in 1939: an improvement of more than 31 per cent. In 1932 the figure was 60.3 cents. We call particular attention to this figure, because the principal development of long-train operation occurred during the period 1924-1932. The increases in average train lengths have been less marked since 1932 than during the previous eight years.

Exhibit 179 (R. 3068-3071).

We call attention also to the comparison by two-year periods, which is set forth in the portion of the finding dealing with the improvement in the system average cost per thousand gross ton miles for selected direct expenses. This comparison by two-year periods avoids any possible criticism which might be made of a direct comparison between individual years; it tends to iron out any inequalities or peculiar conditions which may be associated with particular years. This comparison shows that the combined total improvement, as between the two-year period 1924-1925, and the two-year period 1938-1939 was more than 25 per cent.

This subfinding concludes with a reference to the index of efficiency afforded by the quantity of fuel consumed per thousand gross ton miles. This index corresponds to the other index of fuel efficiency previously mentioned: gross ton miles per ton of fuel. In obtaining this index, the fuel consumed is converted into its equivalent in pounds of coal; the total gross ton miles produced is then divided into the total fuel consumed in order to obtain the amount consumed for each unit of one thousand gross ton miles. On the basis of comparisons by two-year periods, between 1924-1925, and 1938-1939, this index shows an improvement, for all freight trains on the system, amounting to 22.38 per cent.

Exhibit 249, (R. 3258-3261).

We have suggested before, in this discussion, that the substantial improvements in the efficiency and economy of train operations on the appellant's system is no mere accident or coincidence. The finding compares the improvement as between the years, such as 1922, 1923 and 1924, when the long-train program had not yet been adopted, and 1932, 1938 and 1939, all of which were years when the long-train program had reached substantial development everywhere on the system except in the affected territory. The record shows that the improvement has been continuous and progressive year by year, with only incidental departures from the general trend, just as the development of the long-train program has also been continuous and progressive. If only one or a comparatively small number of these several indices indicated improvement, while others were stationary, it might be possible

to argue that the long-train program had had no effect; but where the improvement in efficiency and economy is so definite and consistent, and has continued year after year, side by side with a continuing increase in the average lengths of trains and the proportion of long trains operated, there can be no question but that the increased efficiency and economy must be credited to the long-train program. Certainly there is no possible foundation for any contention, nor has any been suggested by appellee, that the long-train program has prevented or impeded the development of efficiency and economy on the system.

(2) In the Nevada-Utah territory (R. 3927-3929):

Paragraph 2 of Finding VII(b) summarizes the showing made on appellant's various exhibits which set forth the improvements in efficiency and economy of freight-train operations in Nevada and Utah during the period 1922 to 1939, inclusive. This showing relates to both the State of Nevada and, more particularly, to the Salt Lake Division, because the underlying data from which the statistics were directly computed largely relate to division operations. In the same manner any of the indices of efficiency and economy referred to in subparagraph (3) of this finding, which relates to results of operations in Arizona and the affected territory generally, are taken from statistics of the Tucson Division. It is not disputed that Salt Lake Division statistics reflect the Nevada operations with reasonable accuracy, for practically all of the lines in Nevada are included within the Salt Lake Division.

Exhibit 154 (R. 3028).

In Finding VII(b) are set forth the average lengths of freight trains on the system, and in Nevada and on the Salt Lake Division, for certain years between and including 1920 and 1939. It is there shown that there has been a rather consistent increase, year by year, in both Nevada and on the Salt Lake Division, commencing in about 1925, and continuing to the present time. Throughout the years, the Nevada and Salt Lake Division average train lengths have consistently been much greater than the system average; and this is particularly true since and including 1927.

If the theory were correct, as has sometimes been suggested, that long-train operation results in greater difficulty of freight-train handling, average train speeds on the Salt Lake Division should be less than the system average, and particularly less than the Arizona or Tucson Division averages; and the substantial increase in average lengths on the Salt Lake Division should have been accompanied by a decline in average train speeds, or at least by a failure to achieve the same improvement as on the system or the Tucson Division. The results, as presented upon appellant's exhibits, particularly Exhibit 180 (R. 3072), are exactly the contrary. In 1922, the average speed of main line freight trains on the Salt Lake Division was 14.7 miles per hour, at which time the average train length (52.0 cars) was considerably less than on the Tucson Division; in 1932 the corresponding figure was 19.7 miles per hour, the average train length having increased to 81.0 cars; and in 1939 the average speed was 21.4, the average train length being 85.4 cars. The improvement, contrasting 1939 with 1922, was 45.5 per cent. It is clear that the

predominant long-train operation in Nevada and Utah had the effect of causing rather than preventing substantial increases in average speed of freight trains.

The index of average gross ton miles per freight-train hour likewise shows a consistent and very substantial improvement on the Salt Lake Division; and the absolute figures are much higher than for the system as a whole, or for the Tucson Division. The Salt Lake Division improvement, contrasting 1939 with 1922, was 146.4 per cent, and the absolute figure on the Salt Lake Division in 1939 was nearly 75 per cent greater than the system figure, and about 53 per cent greater than the Tucson Division figure. The average cost per thousand revenue ton miles, for all Nevada freight-train operations, both main and branch, declined by 37.8 per cent during the period 1922-1939; the system improvement during the same period was 36.5 per cent; while the corresponding improvement in Arizona was only 25.7 per cent.

Exhibits 161 (R. 3035), 193 (R. 3105).

We have previously referred to the selected direct expenses associated with operation, and the figures of average cost per thousand gross ton miles, for all freight trains operated on the system. Similar figures are of record for the Salt Lake Division. This cost on the Salt Lake Division declined from 56 cents, in 1924, to 35.4 cents in 1939; an improvement of 36.7 per cent. On the basis of comparisons by groups of two-year periods, the improvement as between 1924-1925, and 1938-1939, was 27.72 per cent. The earlier period was, of course, prior to the general development of long-train operation on the divi-

Superior Court, Pima Co., Arizona
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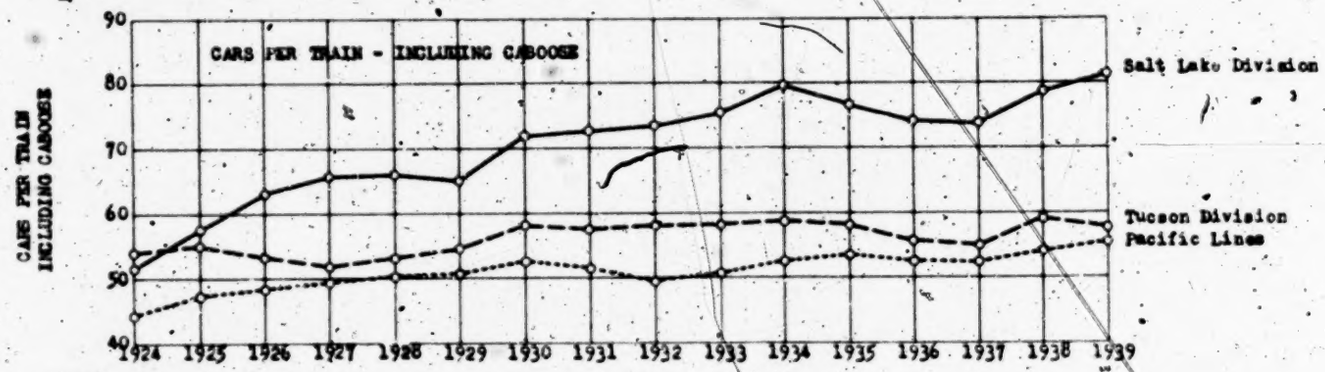
Defts. Ex. No._____(Witness_____)

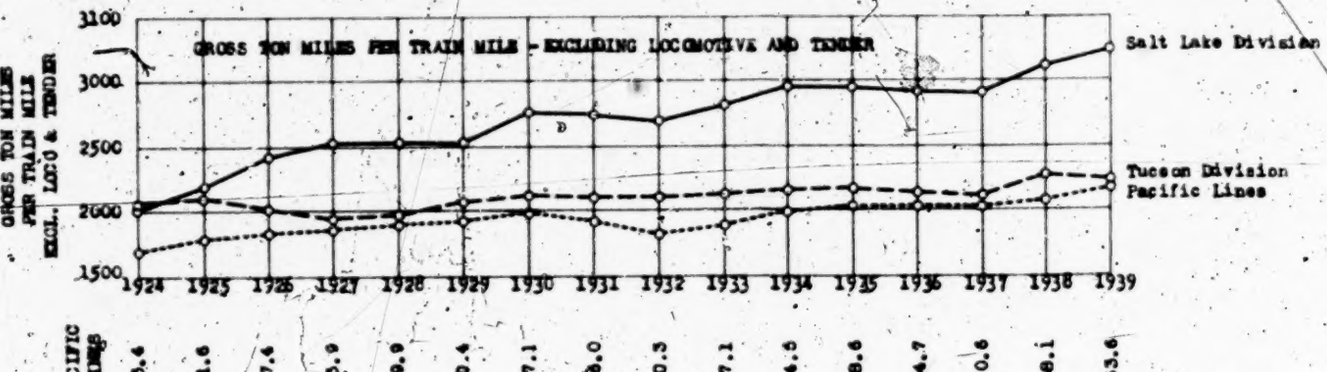
SOUTHERN PACIFIC COMPANY
(Pacific Lines)

MAIN AND BRANCH LINE FREIGHT TRAIN COMPARISONS
TUCSON AND SALT LAKE DIVISIONS AND PACIFIC LINES
CARS PER TRAIN, GROSS TON MILES PER TRAIN MILE,
COST PER 1,000 GROSS TON MILES

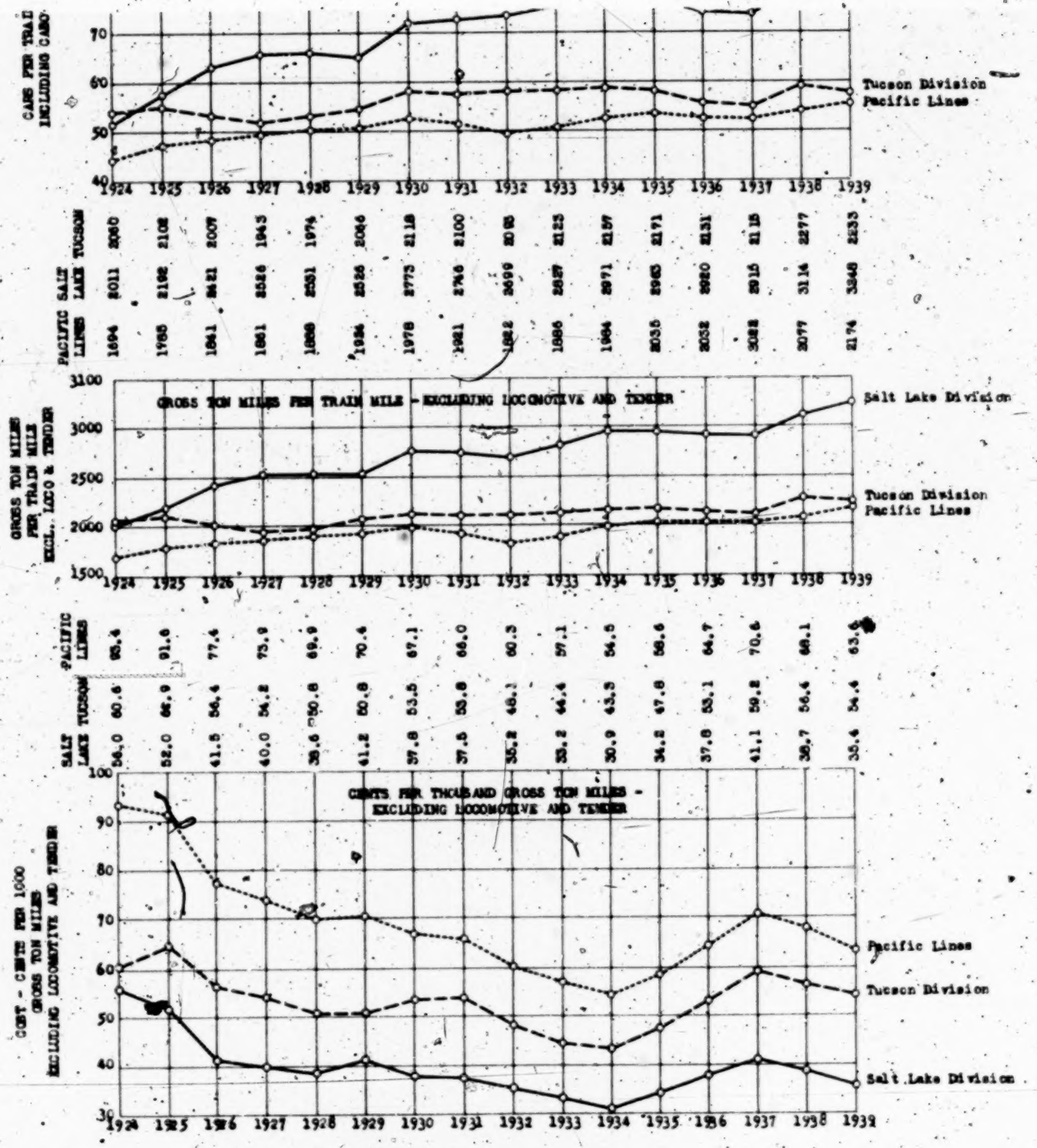
	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939
Pacific Lines	44.6	47.4	48.7	49.3	50.1	50.4	52.5	51.4	49.5	50.6	52.7	53.6	52.7	52.4	54.0	55.6
Salt Lake	51.6	57.6	63.1	65.8	66.2	65.2	72.0	72.9	73.4	73.5	73.7	76.7	74.1	73.8	78.6	81.2
Tucson	54.0	55.1	53.3	51.8	52.0	54.5	58.0	57.6	58.1	58.2	59.6	59.1	55.6	54.9	59.1	57.8



	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939
Pacific Lines	1694	1786	1841	1861	1888	1924	1978	1921	1882	1886	1984	2035	2052	2028	2077	2174
Salt Lake	2011	2192	2421	2526	2551	2526	2773	2746	2699	2827	2971	2965	2920	2915	3114	3348
Tucson	2080	2102	2007	1943	1974	2036	2118	2100	2085	2125	2197	2171	2131	2115	2277	2233



	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939
Pacific Lines	85.4	91.6	77.4	75.9	69.9	70.4	67.1	68.0	69.3	67.1	64.5	58.6	64.7	70.6	68.1	63.6


CARS PER TRAIN INCLUDING CABO
70
60
50
40
1924 1925 1926 1927 1928 1929 1930 1931 1932 1933 1934 1935 1936 1937 1938 1939
Tucson Division
Pacific Lines
PACIFIC LINES 1664 1985 1841 1861 1888 1934 1978 1921 1822 1886 1964 2035 2052 3028 2077 2174
SALT LAKE 2011 2192 2421 2526 2551 2525 2773 2746 2699 2827 2871 2965 2920 2915 3114 3348
TUCSON 2000 2108 2009 1943 1974 2046 2118 2100 2082 2125 2157 2171 2131 2115 2277 2333
GROSS TON MILES PER TRAIN MILE EXCL. LOCO & TENDER
GROSS TON MILES PER TRAIN MILE - EXCLUDING LOCOMOTIVE AND TENDER
3100
3000
2500
2000
1500
1924 1925 1926 1927 1928 1929 1930 1931 1932 1933 1934 1935 1936 1937 1938 1939
Salt Lake Division
Tucson Division
Pacific Lines
PACIFIC LINES 85.4 91.6 77.4 73.9 69.9 70.4 67.1 66.0 60.3 57.1 54.5 58.6 64.7 70.4 68.1 63.6
SALT LAKE 56.0 52.0 41.8 40.0 38.6 41.2 37.8 37.5 35.2 33.2 30.9 34.2 37.8 41.1 38.7 36.4
TUCSON 60.6 66.9 56.4 54.2 50.6 50.8 53.5 53.8 46.1 44.4 43.5 47.8 53.1 59.2 56.4 54.4
COST - CENTS PER 1000 GROSS TON MILES EXCLUDING LOCOMOTIVE AND TENDER
CENTS PER THOUSAND GROSS TON MILES - EXCLUDING LOCOMOTIVE AND TENDER
100
90
80
70
60
50
40
30
1924 1925 1926 1927 1928 1929 1930 1931 1932 1933 1934 1935 1936 1937 1938 1939
Pacific Lines
Tucson Division
Salt Lake Division
LEGEND
Tucson Division
Salt Lake Division
Southern Pacific (Pacific Lines)

sion; while the latter figure represents the costs obtained after the long-train program had reached practically full development.

Exhibit 179 (R. 3068-3071).

The operation of substantially longer trains, and of more long trains in proportion to the total, has resulted in a particularly favorable showing of fuel economy on the Salt Lake Division. In 1924, when the average length of all trains (main and branch) on the division was 51.6 cars, the average fuel consumed per thousand gross ton miles for all such freight trains was 100 pounds. In 1939, when the corresponding average train length was 81.2 cars, the corresponding index of fuel consumption had dropped to 73 pounds; an improvement of 27 per cent. The comparison by groups of two-year periods shows a similar result: the index for the two-year period 1924-1925 having been 96.2, and for the two-year period 1938-1939, 73.9. The combined total improvement was 26.06 per cent.

Exhibits 178 (R. 3067), 249 (R. 3258-3261).

For convenient reference we here reproduce Exhibit 178, which sets forth a graphic comparison of efficiency and economy in relation to average train lengths, as between the system and the Tucson and Salt Lake Divisions.

The effect of variations train lengths upon the average cost of performing freight-train service is well exemplified by Exhibit 177 (R. 3066). The exhibit shows the month-to-month variations in average expense per thousand gross ton miles, for freight-train service on the

Tucson and Salt Lake Divisions, set side by side with the average train lengths, month to month, for the 36 months included in the years 1937, 1938, and 1939. The exhibit demonsfrates precisely that in those three years, as the average train length varied from month to month, the average expense of freight-train service varied inversely; increasing train lengths were accompanied by reductions in average cost, almost in precise proportion. Thus, on the Salt Lake Division in January, 1938, the average train length was 70.6 cars; the average selected expense cost per thousand gross ton miles was 45.5 cents. In February the average train length declined to 66.8 cars, and the average expense increased to 48.6 cents. In May, with an average train length of 80.3 cars, the average expense declined to 37.8 cents. A slight decline in average train length during June brought a slight increase in average expense. Further increases in train length, to a high figure of 85.4 cars per train during August, brought a reduction of expense to 34.8 cents. As train lengths tended to decline thereafter, during the balance of the year, reaching a figure of 78.3 in December, so average expenses tended to rise, reaching a figure of 39.3 cents for the same month.

Even on the Tucson Division, where variations in train length are much less marked than on the Salt Lake Division, primarily because of the 70-car maximum and the natural tendency of the appellant to operate as many of its trains as possible with the maximum number of cars permitted, the close relationship between variations in train length and inverse variations in unit cost are equally apparent. The showing demonstrates that not only in

Nevada, but also in the affected territory, increases in train lengths tend to be accompanied by reductions in average unit cost of train operation; and equally that an arbitrary restriction which compels the operation of trains of shorter average lengths, and in greater number than otherwise required, is accompanied by a definite tendency toward increase in cost.

We emphasize again the fact that substantially greater efficiency and economy are shown to have been accomplished in the Nevada-Utah territory than on the system generally, or in Arizona. This result is due to a combination of several causes. In the first place, the traffic handled over the Nevada-Utah lines is almost entirely through traffic, and the operating and other conditions in that territory, like those in Arizona, are favorable to the movement of traffic in long-train units; whereas on the system generally, operating conditions vary greatly, and there is much local traffic in certain districts. Furthermore, the greater efficiency and economy in Nevada and Utah have been achieved independently of any influence of the Arizona law; whereas the restrictions of that law prevent the attainment of comparable efficiency and economy in Arizona and the adjacent affected territory, and tend to bring down the system performance, but do not affect the results of the Nevada-Utah operations.

(3) Defendant's inability to achieve comparable efficiency and economy in the territory affected by the Arizona Train-Limit Law (R. 3929-3934):

In the subfinding bearing the above title, we set forth an analysis of the Arizona operations, from the stand-

point of efficiency and economy, employing the same indices as for the system generally and for the Nevada-Utah operations.

The statistics thus summarized relate largely to the Tucson Division, but to some extent to the State of Arizona. The main lines of the Tucson Division include nearly all of appellant's principal main lines in Arizona, excluding only the alternate main line between Mescal and the Arizona-New Mexico boundary west of Rodeo, New Mexico (the so-called Douglas line), and including about 17 miles of main line in New Mexico west of Lordsburg, where the Arizona law operates with extra-territorial effect. The main lines of the Tucson Division thus include all of the Yuma-Gila-Lordsburg line west of Lordsburg.

Exhibit 154 (R. 3028).

Reference is made in the finding to the fact that the boundaries of the Tucson Division were changed in 1930, by the addition of the main line between Tucson and Lordsburg, and the branch line between Bowie and Live Oak. As stated in Finding VII(a), the boundaries of the Salt Lake Division were also changed in 1929, by the addition of the main line between Wendel and Alturas, California, and at the same time the Fernley-Wendel line was reclassified as main line. These changes in divisional boundaries do not, of course, affect any comparisons between the states of Nevada and Arizona; for the lines affected by the changes were of course continued in their previous locations. The method of comparison employed, whereby the years are grouped according to periods prior

and subsequent to the changes of divisional boundaries, eliminates any disturbing effect which might otherwise result therefrom. In point of fact these disturbances are very minor, and in so far as concerns comparisons either between the two divisions, or between the earlier or later groups of years, could very properly be disregarded.

It was possible to group the years prior and subsequent to 1930, in making these comparisons, because the Tucson Division operating statistics for the year 1930 were recomputed, or "restated," in 1931, so as to reflect operations for the year 1930 as if the change of divisional boundaries had taken place at the beginning of that year instead of in July. This restatement permits a true comparison between 1931 and 1930 operations, and likewise between 1930 and later years in the same manner. The Salt Lake Division statistics were likewise available for the year 1930, without any disturbing effect caused by the change made in November, 1929.

Mason, R. 1212.

The outstanding conclusion, to be drawn from the showing for the affected territory, is stated in the initial paragraph of subfinding VII(d)(3). The improvements in road and equipment made in Arizona are comparable to and as extensive as in Nevada and Utah, or on other parts of the system; the operating rules are the same; and the volume and character of the traffic handled, and the operating conditions, are essentially similar in both Arizona and Nevada; but nevertheless the improvements in efficiency and economy achieved in the affected territory are substantially less than in Nevada and Utah. Since the

only differentiating factor, as between Nevada-Utah, on the one hand, and the affected territory, on the other, is the Train-Limit Law itself, this failure to achieve comparable efficiency and economy can and must be ascribed only to the law's restrictions.

Thus, dealing first with the matter of average freight-train speeds: the Tucson Division improvement in speeds of main-line freight trains was 40.8 per cent as between 1923 and 1939; on the system the improvement was 58.9 per cent, and on the Salt Lake Division 45.5 per cent. It is particularly significant that between the years 1922 and 1932, which were the years of major development of the long-train program, the Salt Lake Division improvement was 34 per cent; the system improvement was 47.3 per cent; but the Tucson division improvement only 21.1 per cent.

Exhibit 180 (R. 3072).

The important index of efficiency, presented by gross ton-miles per train hour, shows some improvement on the Tucson Division as between 1923 and 1932 (26.7 per cent); but the corresponding improvement on the Salt Lake Division was 98 per cent. Comparing 1939 with 1923, the Tucson Division improvement was 55.5 per cent; but the Salt Lake Division improvement was 146.4 per cent.

Comparison may also be made between 1939 and 1930 for both divisions. This comparison escapes any possible criticism which may be made because of the fact that the division limits on both divisions were changed about the year 1930. It also compares a period of general long-train operation on the Salt Lake Division with a period

of completely restricted operation on the Tucson Division. In this period the gross ton miles per train hour for all trains on the Tucson Division improved 24.5 per cent; but the corresponding improvement on the Salt Lake Division was 41.8 per cent. Clearly this much greater improvement simply reflects the advantage of the long-train program in Nevada-Utah on the one hand, and the hampering effect of the law's restrictions in Arizona on the other.

Exhibit 193 (R. 3105).

The index of average net tons of freight per main-line freight train shows an actual reduction on the Tucson Division from 1923 to 1932, amounting to 24.1 per cent, whereas on the Salt Lake Division during the same period there was an increase of 9.9 per cent. Comparing 1939 with 1932, the increase on the Tucson Division amounted to approximately 24 per cent; but on the Salt Lake Division it was 33.4 per cent.

Exhibit 193 (R. 3105).

Turning to cost figures: the average cost per thousand revenue ton miles, for all operating expenses for all freight-train operations within Arizona, shows an improvement (reduction) of 25.7 per cent, comparing 1939 with 1922; but the improvement in Nevada over the same period was 37.8 per cent. Comparing the four-year period 1936-1939 with 1922-1925, the Arizona improvement was 19.5 per cent; but the Nevada improvement was 30.7 per cent.

Considering the average cost per thousand revenue ton miles, for transportation expenses only, for freight-train operations in the two states, there was but little change

in Arizona between 1922 and 1939, the improvement (reduction) having been only 8.7 per cent. The corresponding Nevada improvement was 31.6 per cent. Comparing the same four-year periods previously mentioned the Arizona improvement was 6.8 per cent; but the Nevada improvement was 24.4 per cent. Cost figures for transportation expenses only, as above stated, take into account the costs directly associated with train operations, a substantial proportion of which consists of fuel, locomotive repairs and wages of train and engine service employes. These items tend to increase directly with the number of trains run; and the failure to obtain any substantial improvement in Arizona clearly reflects the influence of the Train-Limit Law, in compelling the running of many more trains, and the consequent production of a substantially increased volume of train miles, than would otherwise be necessary for the handling of the traffic. By contrast, the Nevada figures attest the economies in these particular items of expense, which have been achieved as the result of the long-train practice, and the consequent elimination of unnecessary trains and train miles in that state.

Exhibit 160 (R. 3034), 161 (R. 3035).

Two of the comparisons set forth in Finding VII(d)(3) are by groups of years prior and subsequent to 1930. These comparisons include particularly, cost per thousand gross ton-miles for selected direct expenses of freight-train operations, and figures of fuel consumption per thousand gross ton-miles for freight trains on the Tucson and Salt Lake Divisions. This method of comparison, as before stated, has the effect of producing figures showing

relative improvements over the years considered, without any possible distortion resulting from the changes in the boundaries of the two divisions during the period. These comparisons show combined total improvements, comparing 1924 and 1925 together with 1928 and 1929, and then comparing 1930 and 1931 together with 1938 and 1939, amounting, in the case of average cost per thousand gross ton-miles for direct expenses of freight-train operations, to 15.93 per cent on the Tucson Division, and 27.72 per cent on the Salt Lake Division; and, considering average pounds of fuel consumed per thousand gross ton-miles, to 12.62 per cent on the Tucson Division, but 26.06 per cent on the Salt Lake Division. Considering fuel consumption during the years following 1930, there was a decrease, in the index of gross ton-miles per ton of fuel for all freight trains, on the Tucson Division, of 0.5 per cent, comparing 1939 with 1930; but an improvement on the Salt Lake Division of 15.3 per cent.

Exhibits 179 (R. 3068-3071), 249 (R. 3258-3261).

The finding concludes with the statement that appellant's inability to effect improvements in the efficiency and economy of its freight-train operations in Arizona, comparable to those achieved in Nevada or upon the system generally, has been and is largely and directly due to the restrictions imposed by the Arizona law. This conclusion of fact is not merely justified; it is unavoidable. In preceding findings it is set forth that the operating conditions in Arizona are essentially similar to, if not slightly more favorable than, those in Nevada; that the characteristics of the traffic handled are practically the same;

that the volume of the traffic, over the years studied, has been about the same, year by year, in both states. The operating rules are virtually identical. The same equipment is used interchangeably in both states, and the same standards of construction and maintenance are observed. No attempt was made to show that Nevada employes render any better or more efficient service in the handling of trains, within the limits imposed by rule, law and custom, than their fellow employes in Arizona. Appellee called no employes of appellant as witnesses to testify respecting Nevada operations, and made no attempt in its case in rebuttal to draw any distinction between operations in Nevada and Arizona. In these respects our showing is wholly uncontradicted. Since there is shown to be substantial identity of all of the conditions which may or might affect the result, except the single factor contributed by the restrictions of the law, the substantial differences in the results obtained from the Arizona operations must be ascribed to that one differentiating factor, and to that alone.

This finding is not only material, but highly important, because it bears so directly upon the results which have followed from compliance with the Arizona law, and also indicates clearly the results which would unquestionably follow if the restrictions of the law were removed. It presents the results of appellant's actual experience with methods of operation exactly as they would be carried on if the law were not in effect, and under conditions which, as we again emphasize, are as nearly identical to those existing in Arizona as could well be obtained.

Like all other subdivisions of Finding VII(d), subdivision (3) is predicated upon the competent testimony, which is reproduced or carefully excerpted from basic records and accounts regularly kept by appellant; and again we point out that this showing was not disputed or challenged in any way by opposing testimony.

VIII.

COMPARISON OF DEFENDANT'S METHODS OF OPERATION WITH THOSE FOLLOWED ON UNITED STATES RAILROADS GENERALLY (R. 3934-3947).

(a) IMPROVEMENTS IN ROAD AND EQUIPMENT (R. 3934-3937).

In subparagraph (a) of paragraph 3 of Part III of the answer (R. 9) it is alleged in substance that in recent years "great improvements have been made in both road and equipment . . . on railroads throughout the United States generally." Finding VIII(a) responds to the issue thus tendered.

This finding not only disposes of this issue of fact, but also and more precisely demonstrates, by an affirmative statement, that the improvements in its own property, accomplished by appellant, as detailed in Finding VI, were not isolated or exceptional, but part of a nation-wide program agreed upon and carried out by all of the major railroads of the United States, acting more or less in concert.

Parmelee, R. 187-190, 194-195.
Exhibit 15 (R. 2863).

The essential fact is that when appellant undertook its extensive investments, and constructed or purchased the improvements which have enabled it to adopt and follow the long-train practice, and thereupon did adopt and now employs that practice, it was proceeding along the same progressive course, followed at the same time by other railroads generally, including the major trunk lines with which it competes and connects. The Arizona law obstructs the development and employment of progressive modern methods of railroading, by forbidding appellant and the Atchison, Topeka & Santa Fé Railway Company, the other major Arizona line, to use one of the most essential and universal of these methods, and imposes instead upon these two railroads an additional and arbitrary restriction from which many of their principal competitors are free.

In a sense, Finding VIII(a) is the preliminary part of what may properly be termed, collectively, the "national finding." We shall not undertake to analyze in detail the testimony upon which the finding is based. The statistical showing is founded largely, if not entirely, upon official publications of the Interstate Commerce Commission. The competency of such statistics cannot properly be challenged. The oral testimony was given by experienced and fully qualified statisticians (Messrs. Parmelee and Otterback), and by experienced railroad operating officers, presently engaged in the active supervision and conduct of the operations of their respective systems. No opposing showing of any character was attempted by appellee.

(b) **INCREASED TRAIN LENGTHS (pp. 68-71).**

Paragraph VIII(b) responds to the allegations of subparagraph (d) and (e) of paragraph 3 of Part III of the answer (R. 11-12), wherein it is stated that the long-train practice has been since about the year 1924, and now is, the common practice throughout the United States; that the maximum length of freight trains on main trunk lines throughout the nation is much greater than permitted by the Arizona law; and that the standard long-train practice is general on major trunk lines, including the main lines of appellant's principal competitors and connections.

Parmelee, R. 223-225.
Exhibit 22 (R. 2870).

The finding in this paragraph thus carries forward the story of the national situation. It shows that the operation of long trains by appellant was and is in line with the best and most progressive modern practices which have been and now are regularly followed; and that the restricted operation which the Arizona law compels is unusual, extraordinary, and, in the light of national experience, both unwise and unnecessary.

We call attention to the number of systems and the total mileage as to which specific testimony of operating methods was introduced. This detailed testimony covered methods of operation followed upon railroad systems extending into every section of the United States. These carriers, in 1939, operated 125,885 miles of line, or more than 50 per cent of the total of the mileage of Class I railroads in the United States, and produced more than 13 billion freight-train miles, about 59 per cent of the total

of all Class I railroads, and more than 13½ billion revenue passenger miles, or about 60 per cent of the total for all Class I carriers. The railroads covered by this testimony include all or nearly all of appellant's competitors, and likewise nearly all of the lines which connect with and join appellant in handling through traffic between Pacific Coast points, on the one hand, and destinations on and east of the Missouri and Mississippi Rivers, on the other.

Exhibit 248 (R. 3257).

(c) IMPROVED SCHEDULES AND PERFORMANCE (R. 3939-3940).

In paragraph 3(b) of Part III of the answer (R. 10), and again in paragraph 3(e) (R. 12), it is alleged that freight is transported between all parts of the United States in long trains upon dependable schedules which are from one-half to one-third faster than performed prior to 1924; that the practice of standard long-train operation does not retard the movement of traffic, but expedites such movement materially and promotes and makes possible early delivery. Finding VIII(c) is addressed to the issue thus tendered.

Schedules similar to those maintained by appellant and its connections, between Pacific Coast points and eastern destinations (described in Finding VII(c), R. 3920-3924), are generally maintained by the major railroads in the United States, and frequently participated in by three or more connecting carriers. These schedules were instituted as a part of an organized effort of the railroads of the nation toward betterment of service; and as improved

operating methods were developed, including particularly the long-train practice following 1923, these schedules and the performances under them were improved. . .

This finding condenses the lengthy testimony of numerous witnesses, officials of railroads other than appellant, who testified as to the operations of the carriers by which they are employed. It is not necessary to review this testimony in detail; the finding presents its essentials. Every part of the finding is fully supported by highly competent testimony, the correctness of which has never been challenged.

(d) INCREASED EFFICIENCY AND ECONOMY (R. 3940-3942).

Finding VIII(d) presents another phase of the national picture, and corresponds in that respect with Finding VII(d), wherein the effect of the long-train program on the efficiency and economy of appellant's operations is set forth. This finding sets forth the results for both the United States carriers as a whole, and in a general way for a number of individual railroads, of the adoption and development of the 1923 program of betterment, and particularly the long-train operating method which forms an essential part of that program.

In the finding reference is made to a number of the indices of efficiency and economy which were also used in Finding VII(d). For example, referring to road speed of freight trains, the finding shows an increase in the average for all Class I railroads from 11.1 miles per hour in 1922, to 16.7 miles per hour in 1939: an improvement of 50.5 per cent. As to fuel consumption, indicated by the

gross ton miles produced per ton consumed, the index increased from 10,750 in 1923, to 15,528 in 1939: an improvement of 44.4 per cent. Freight train performance, expressed in gross ton miles per train hour, for all freight trains of Class I carriers, more than doubled between 1922 and 1939; the increase was from 16,188 in 1922 to 32,808 in 1939: an improvement of 102.7 per cent.

Exhibit 22 (R. 2870).

In the *Railroad Retirement Act Case*, supra, this Court discussed statistics of the same kind, there presented for the purpose of showing the efficiency and economy of carrier operations generally. The Court said (295 U.S., at p. 366):

> "How stands the case for efficiency? Here again the record without contradiction demonstrates that in step with the alleged progressive superannuation on the railroads their operations have increased in efficiency. The trial court found, and its finding is not assigned as error: 'Railroads were, when the Act was enacted, and are now, operated efficiently and safely and more efficiently and much more safely than at any time in history.'"

In a footnote to the excerpt just quoted, the Court said further:

> "Thus it appears that the average speed of freight trains between terminals in 1928 was 10.9 miles per hour, in 1929 was 13.2 miles per hour, and in 1933 was 15.7 miles per hour. Excluding weight of locomotive and tender each freight-train hour in 1928 produced 16,764 gross ton-miles; in 1929 produced 24,539 gross ton-miles; and in 1933 produced 27,34[illegible]

gross ton-miles; and net ton miles per freight-train hour increased 41.2 per cent. from 1923 to 1933, and 3.7 per cent. from 1929 to 1933. Cost of transportation is also shown to have decreased in the same periods."

It will be noted that the Court recited the fact that the cost of transportation was shown to have decreased. The finding sets forth that the average expense per thousand revenue ton miles, for all freight operating expenses of Class I railroads, declined from $8.71 for the four years 1922-1925, to $6.49 for the four years 1936-1939; a reduction or improvement of 25.5 per cent. Referring to average expense per thousand revenue ton miles, for freight transportation expenses only, the corresponding improvement (reduction), comparing the two 4-year periods just mentioned, was 23.6 per cent. Turning to expenses in passenger-train service, the improvement in expense per passenger-train car mile, again comparing the two periods just referred to, was 21.74 per cent; or, taking into account passenger transportation expenses only, the improvement, again contrasting the same two periods, was 20.06 per cent.

Exhibits 20 (R. 2868), 21 (R. 2869).

We call particular attention to the increase in efficiency and economy evidenced by the fact that the Class I railroads were able to handle their aggregate revenue freight traffic in the four years 1936-1939, which amounted to only 15 per cent less in volume than in the four-year period 1922-1925, with an average ownership of 34 per cent less locomotives, and 26 per cent less freight cars; although, as

the evidence establishes, the traffic was handled more cheaply, at higher speeds, and on faster schedules.

Exhibits 20 (R. 2868), 33 (R. 2882-2883), 37 (R. 2889).

The record of efficiency and economy for individual railroads, as shown by the testimony of witnesses representing sixteen major systems other than appellant, corresponds to the record of the United States railroads as a group. These sixteen systems include carriers in every major section of the country; the long-train operating method is the standard practice on their lines, except to the extent that the Santa Fe cannot operate long trains in Arizona and adjacent territory.

The finding responds to the allegation found in subparagraph (e) of paragraph 3 of Part III of the answer (R. 12) that long trains are commonly, safely and economically operated throughout the United States, and the allegation that the long-train operating practice has proved an efficient method of operation (answer, Part III, paragraph 3(b); R. 10).

(e) RESULTS OF THE LONG-TRAIN PROGRAM FROM THE STANDPOINT OF THE PUBLIC, THE EMPLOYES, AND THE RAILROAD OWNERS (R. 3943-3945).

(1) Reduction in average transportation charges paid by the public (R. 3943).

In subparagraph (d) of paragraph 3 of Part III of the answer (R. 11-12) it is alleged that the improved methods of operation, of which long-train operation is an essential part, adopted following 1923, have resulted in substantial

public benefits. Finding VII(e) sets forth that these benefits have extended to the public at large which patronizes the railroad industry, and to railroad employes; but shows also that the same benefits have not been experienced by the railroad owners, in spite of the generally increased efficiency, economy and safety of railroad operation.

Subparagraph 1 particularly shows the benefits realized by the general public from the reduction in average transportation charges paid. It is shown that the reduction in average freight charges was, between 1922 and 1939, 17.4 per cent; and in average passenger fares, 39.2 per cent. These are benefits directly received by and accruing to the general public.

Exhibit 16 (R. 2864).

(2) Increases in average wages paid to employes (R. 3943-3944):

Subparagraph 2 of this finding sets forth particularly the benefits accruing to railroad employes, as an incident of and accompaniment to the long-train practice, and the general betterment program adopted following 1923. Expressed in average rates per hour, the wage-level for all employes advanced 22.1 per cent since 1922, to an average figure of 74.9 cents per hour in 1939. Dealing particularly with train and engine-service employes, who form the classes of employes particularly affected by the Train-Limit Law, the average hourly wage increased between 1922 and 1939 to 92.2 cents, an increase of 16.5 per cent. These are, of course, substantial and continuing benefits to the employes concerned.

Exhibits 17 (R. 2865), 18 (R. 2866).

(3) Effect on returns to owners of the railroads (R. 3944-3945):

This paragraph of the finding presents the results of the 1923 betterment program, from the standpoint of the financial returns to the railroad owners. It shows that the benefits have been largely, if not entirely, absorbed in the reductions in charges extended to the general public, and increases in wages given to the railroad employes. In so far as concerns actual income from the operations of the railroad properties, the returns earned, particularly since and including the year 1930, have been very small; in at least four years substantial deficits were experienced, and in no year since and including 1931 has there been a percentage return in excess of 2.57 per cent.

Exhibit 19 (R. 2867).

These findings thus emphasize that the 1923 betterment program, and the long-train operating practice as an essential feature thereof, have not operated merely to promote the self-interest of the owners of the properties; on the contrary, they have principally contributed genuine and long-lasting benefits to the general public which the railroad industry serves and to the vast number of persons who depend directly upon the railroad industry for their employment and support; but they have not operated, except to the extent of preventing or minimizing operating losses, to benefit the actual owners of the railroads in any corresponding degree.

(f) SIMILARITY OF OPERATING CONDITIONS AND OPERATING RULES ON OTHER RAILROADS TO THOSE PREVAILING UPON DEFENDANT'S LINES IN THE AFFECTED TERRITORY (R. 3945-3947).

In paragraph 3(e) of Part III of the answer (R. 12), after referring to nation-wide operation of long freight and passenger trains, it is alleged that the operating conditions under which such operations are carried on are substantially as favorable as those on the appellant's main lines in Arizona. Finding VIII(f) relates directly to the issue thus tendered.

The operating conditions in the affected territory are set forth at length in Findings III and VII. The testimony and exhibits relative to operations upon the other individual railroads which were severally represented by witnesses called by appellant contain a showing of the operating conditions upon these railroads, particularly in the districts covered by the several "long-train" exhibits. In general, it appears that the traffic handled under the long-train practice, upon other railroads, is largely of the same kind as handled in appellant's trains in the affected territory; that the grades vary from level to 1.5 per cent or less, about the same as in Arizona; that there are both single-track and double-track operations on these railroads, and in the particular districts studied, which is also true of Arizona operations; that the same general code of operating rules is followed; in short, that the circumstances under which the long-train practice is followed on these other railroads, from whatever standpoint considered, and while they present a variety of situations are such as to duplicate to a greater or less extent the con-

ditions encountered in at least some part of the affected territory.

One purpose of this finding is to make clear that there is no substance to the objection, continually insisted upon by counsel for appellee, that comparisons between operations of the appellant in Arizona and the adjacent affected territory, and operations on other railroads were incompetent or immaterial. The finding shows also that no special or unusual conditions exist in Arizona which justify the arbitrary imposition of a restriction which compels appellant to depart from the accepted and ordinary methods of operation, generally followed upon the lines of other carriers in the United States, both at the present time or for at least sixteen years last past; and that in seeking to conform its practice to the practice of other carriers, including its principal competitors and connections, appellant only desires to follow methods found by experience to be efficient and economical, and to result in speedier and safer transportation service, under conditions not essentially different from those which prevail in Arizona; in other words, to show that it is impossible to point to any experience of operating results gained upon the other railroads of the United States under conditions similar to those encountered in Arizona, which does not condemn as unreasonable, illogical, and unnecessary, the purely arbitrary limitations created by the Train-Limit Law.

IX.

RECENT LONG-TRAIN OPERATIONS OF DEFENDANT IN ARIZONA: INTENTION TO UNDERTAKE FUTURE LONG-TRAIN OPERATIONS (R. 3947-3950).

(a) LONG-TRAIN OPERATIONS OF DEFENDANT IN ARIZONA IN 1940 (R. 3947-3948).

In this finding there is included specific reference to the limited long-train operations undertaken in Arizona by appellant during the months of March and April, 1940. The complaint refers (R. 2-4) to two such long trains; but the testimony shows that long passenger trains were operated in Arizona on 62 different occasions between and including March 2nd and April 30, 1940 (*Exhibit* 246, R. 3255) while 302 long freight trains were operated during the 27 days between April 4 and April 30, 1940 (*Exhibit* 234, R. 3231). Practically all of the testimony relating to these long-train operations was adduced by appellant, either through its own witnesses or by questioning of appellee's witnesses; except, of course, the purely formal testimony of appellee's witnesses in chief, offered for the purpose of proving the operation of the two trains particularly referred to in the complaint. The finding shows the total volume of the traffic handled in the long trains operated by appellant, measured in passenger and freight car miles accumulated within Arizona; and shows also that the long freight trains had an average length of 85.36 cars.

Exhibit 295 (R. 3424).

It is also stated, and we call particular attention to the fact, that this long freight-train operation was necessarily

upon a limited scale, because the fixed physical plant in Arizona is not presently adapted to long-train operation upon the same scale as prevails upon appellant's lines in Nevada, for example; furthermore, because the necessary changes in locomotive assignments, which would be carried out if unrestricted long-train operation were undertaken, were not made for the purposes of the 1940 operation.

One particular and important limitation is afforded by the fact that most of the passing tracks along the single-track main lines in Arizona will not accommodate trains of more than 70 cars. Because of this, the long freight-train operation was largely confined to the movement of long trains in the westward direction only.

This finding is important in that it serves as a foundation for the subsequent finding setting forth the effect of the law upon appellant's operations, and the amount of savings and other benefits capable of being realized if the law's restrictions are removed. It is also preliminary to certain findings relative to safety; for, as appears more fully in those findings, the long-train Arizona operations of 1940 were not attended by any accident or casualty occurring upon a train operated in disregard of the law's provisions, as to which it was made to appear or could reasonably be contended that the length of the train had any bearing whatsoever upon the accident.

Sines, R. 1820-1835, 1860-1863.

Exhibits 197 (R. 3114), 234 (R. 3231), 235 (R. 3232), 246 (R. 3255), 295 (R. 3424).

The finding is important also because of its direct bearing upon the fundamental question in the case: namely, whether long-train operation is feasible and practicable, and capable of being conducted with reasonable safety, in Arizona; or whether there are, on the other hand, some peculiar conditions which justify the continuance of the restrictions. The Arizona 1940 long-train experience clearly demonstrates the entire practicability of such operations, and refutes any contention that peculiar conditions exist in Arizona which set that state apart from the other states in which the long-train practice has been so long and so successfully followed.

(b) FUTURE LONG-TRAIN OPERATIONS CONTEMPLATED BY DEFENDANT: CHANGES IN PLANT AND EQUIPMENT (R. 3948-3950).

In this finding there is set forth the fact, which is both undisputed and directly material to the question whether appellant suffers any substantial injury or impairment because of the law, that appellant plans and intends, if the law's restrictions are removed, immediately to commence and thereafter to continue the operation of long trains in the affected territory. The finding then sets forth the changes in physical plant and equipment necessary for the purposes of such operation on the same substantial scale as is followed in Nevada and elsewhere upon appellant's system.

The necessity for these changes, and the cost of the changes thus contemplated, are fully established by competent testimony. There will be need for a considerable number of siding extensions, and other changes in the

physical plant in order to permit larger locomotives and longer trains to be readily operated; also 30 larger locomotives will be required (on the basis of 1938 traffic volume), and will be substituted for some 51 locomotives presently in service, which will be displaced and made available for use in other territory. With the reduction in the number of train units operated, 21 cabooses now in use will become unnecessary (again assuming the same volume of traffic as in 1938), and there will be a substantial saving on this account.

This finding serves as a preliminary to and foundation for those portions of the next succeeding finding which deal with the amount of the net saving capable of being realized, if long-train operation should become the standard practice in the affected territory, in that it develops the annual charges on additional capital investment, which are deductible from the larger annual operating savings.

Dyer, R. 1115-1117; *Sines*, R. 1404-1405, 1769-1780, 2234-2238, 2251-2252, 2285; *Herbert*, R. 1545-1554, 1570-1574; *Russell*, R. 98-99.

Exhibits 197 (R. 3114), 202 (R. 3151), 205 (R. 3190), 222-255 (R. 3211-3214).

X.

EFFECT OF THE TRAIN-LIMIT LAW UPON DEFENDANT'S OPERATIONS (R. 3950-3969).

In subparagraphs (f), (g), (h) and (i) of paragraph 3, and also in paragraph 4, of Part III of the answer (R. 13-18) are set forth general allegations relative to the

results which follow from appellant's enforced observance of the Train-Limit Law. Thus in paragraphs 3(f) (R. 13), and 4(a) (R. 16-17), it is alleged that the law affects appellant's operations and controls the lengths of its trains, not only in Arizona, but also in adjacent portions of California, and in New Mexico and Texas as far east as El Paso; in paragraphs 3(g), 3(h) (R. 14-15), and 4(c) (R. 18), that the law imposes continuing annual burdens of additional expense upon appellant, amounting to more than $300,000 in the case of freight traffic upon the Yuma-Gila-Lordsburg line alone, and $10,000 in the case of passenger traffic; in paragraphs 3(i) (R. 15-16) and 4(b) (R. 17-18), that the law causes interstate trains and traffic in the affected territory to be greatly interfered with and delayed. In paragraph 5 of Part III (R. 19-22) it is further alleged that the law interferes with and burdens interstate commerce, and produces and increases congestion and train interferences. In paragraph 14 of Part III (R. 28) the allegation appears that the added expense to appellant of enforced obedience to the law is not less than $300,000 annually.

Finding X in its various subdivisions deals with the issues of fact thus tendered. In the interest of a more precise treatment, we shall take up each such subdivision separately in the discussion which follows but before doing so we shall point out how the evidence supporting this finding corresponds and is directly related to the other evidence of record tending to show the effects of the challenged law, and the results which would follow if the restrictions of the law were removed.

In presenting the "national picture", appellant brought before the trial court testimony which showed that the operation of long freight and passenger trains is a practice followed by numerous major railroad systems throughout the country; that it has resulted in greatly increased efficiency and economy of railroad operations; that improved schedules, made possible by the higher train speeds and greater efficiency resulting from the long-train program, have been placed in effect, with resulting benefit to the public at large. The evidence relative to the national picture also shows, as we point out in our discussion of Finding XII, that there has been a marked, continuous, and substantial reduction in the frequency of accidents and casualties, occurring side by side with the development of the long-train program. This national showing, supported as it is by evidence that conditions in Arizona are not essentially distinguished from those in other parts of the United States generally, is of itself sufficient to sustain a finding that the challenged law, in that it prevents the adoption of the same methods of operation in Arizona, impairs the efficiency and economy of railroad operations in that state, reduces the possible benefits to the general public, and hinders the program elsewhere attained in the reduction or elimination of the hazards of railroad operation.

However, appellant did not rest with the presentation of the national picture alone, or the showing of similarity of conditions as between its lines in Arizona, on the one hand, and the lines of United States railroads generally. It presented also a showing of the effects of the long-train program from the standpoint of efficiency, economy, and

safety upon its system as a whole. This testimony, in so far as it bears upon efficiency and economy, and the general achievement of better railroad performance for the benefit of appellant's patrons, is discussed at considerable length in the various subdivisions of Finding VII, and, in so far as it concerns safety, in connection with appropriate subdivisions of Finding XII. By this means appellant has shown that it has achieved upon its own line results substantially similar to those achieved nationally by the carriers as a whole, and individually by its several competitors and connections which were the subject of separate individual showings.

Appellant did not, however, rest its case even with a system showing. It went still further: it selected a portion of the system where the essential conditions, other than the existence of the arbitrary restrictions of the law, are essentially the same as in Arizona. We refer, of course, to the comparisons between Arizona, and the Tucson Division on the one hand, and Nevada and the Salt Lake Division, on the other. In the light of the substantially greater efficiency and economy experienced in the Nevada-Utah territory, as compared to the affected territory, and the substantially greater safety of operation in Nevada than in Arizona, particularly during the period since about 1925 when the long-train practice has prevailed in Nevada, there could no longer be any possible doubt that the law, and the law alone, imposes direct restrictions and hindrances upon appellant's Arizona operations, and instead of promoting safety, actually prevents the elimination of accidents and hazards.

The showing to which Finding X directly relates constitutes a still further method of proving, with a precision not possible in conjunction with the other evidence just discussed, the effects of the Train-Limit Law in imposing additional and unnecessary expense upon appellant, and creating or aggravating delays to and interferences with the traffic handled in the affected territory. In other words, while the experience of appellant in Nevada and upon its system generally, coupled with the experience of the railroads of the United States as a whole or as individuals, compels the conclusion that the Arizona restrictions impose substantial and unnecessary expenses upon appellant, and cause a very definite and inevitable loss of efficiency, that experience does not of itself and naturally cannot indicate precisely what the added expense and loss in efficiency amount to. Furthermore, there is no means of determining from that experience, except in a rather general way, the other effects of the law, such as the interferences with and delays to trains and traffic.

(a) THE REDISPATCHING STUDIES (R. 3950-3953).

For these reasons, appellant undertook the detailed analyses of traffic actually handled in the affected territory, which were presented to the trial court as the "redispatching studies".

In making these studies the methods generally adopted were as follows:

A typical period was selected, during which trains had been operated and traffic had moved, in accordance with the restrictions imposed by the law; and then, having the

records and the results of actual operations available for study, those results were contrasted with the results of the operations which would take place, if precisely the same traffic had moved, under precisely the same conditions, except as modified by removal of the law's limitations.

In other words, the determination was made by following the method employed, for similar purposes, in both the *First Arizona Train-Limit Case*, and the *Nevada Train-Limit Case*, using the experience there gained for the purposes of the instant case.

The initial study (the 1938 freight redispatch) involved the selection of two months in 1938, one of them (June) the month of heaviest traffic and the other (August) the month of lightest traffic. The traffic which actually moved during those two months was studied; and it was contemplated, in that study, that it would move under the same actual conditions, except in so far as the removal of the law's limitations would have permitted or required modifications in appellant's operating methods, and warranted certain changes in equipment and facilities, particularly the substitution of more powerful locomotives, the extension of sidings at certain stations and passing tracks in the affected territory where siding lengths are now 70 cars or less, and necessary changes in locomotive round-house and shop facilities. Because of the fact that the traffic had actually moved in trains limited to 70 cars, it had to be redistributed into longer trains, and those trains had to be "redispatched". The study in its entirety was therefore named the "redispatching study", and is so

referred to in the testimony and findings, and in this discussion.

Sines, R. 1402-1407.

Exhibits 196 (R. 3113), 198 (R. 3115), 205 (R. 3190).

The passenger redispatching study for the year 1938 was conducted in the same manner as the freight redispatching study, except that it was unnecessary for the purposes of that study to assume changes in locomotive assignments, facilities, or siding capacities.

Sines, R. 1406, 1448-1449.

A redispatching study covering Phoenix-Tucson operations for the month of December, 1938, was also undertaken. This study likewise assumed that the traffic would be recast into longer trains, and contemplated the use of longer sidings and locomotives having increased hauling capacity.

Appellant also conducted two separate, but closely related, redispatching studies of the traffic handled during the period April 4th to April 30th, inclusive, 1940, when as stated in Finding IX, appellant operated some 302 long freight trains in Arizona. In the first of these studies the traffic actually handled was redistributed into short trains, it being assumed for the purposes of that study that the restrictions of the law were observed. In this manner appellant was able to ascertain the amount of the saving in train miles and certain direct expenses associated with train operations, achieved by the (actual) limited long freight-train operation, and also to determine

whether there had been any improvement in freight-train performance. For the second of these studies it was contemplated that long-train operation should be undertaken upon the same scale as in connection with the 1938 redispatching study; in other words, the second 1940 study contemplated the use of the more powerful locomotives, extended sidings, and other permanent facilities planned in connection with the 1938 study. The two 1940 studies taken together enable comparisons to be made between (1) a completely restricted operation, (2) the limited long-train operation which prevailed and was hampered by inadequate siding capacities, and (3) a long-train operation predicated upon the use of appropriate locomotives and with adequate sidings and other facilities.

Sines, R. 1397-1410, 1416-1437, 1448-1455, 1517-1526, 2251-2252, 2284-2285; *Baker*, R. 1469-1474, 1483-1486, 1513-1516, 1575-1588; *Herrell*, R. 1487-1509, 2201-2205; *Cassady*, R. 1530-1540, 2214-2215, 2217-2219.

The redispatching studies were supervised and conducted by responsible employes of appellant whose qualifications could not be and were not questioned. The actual work of reconsisting and redispatching the trains was performed by and under the supervision of the chief train dispatchers who had jurisdiction over the lines in the affected territory. Each of these men had had many years of experience in his position and in prior subordinate positions leading to the position of chief dispatcher, and had necessarily become thoroughly familiar with the operation of trains in his particular district or division.

Sines, R. 1401-1402.

The permanent records of the movement of the trains and traffic, consisting of the dispatchers' train sheets, the conductors' time returns and delay reports, the conductors' wheel reports; the train consists, the dispatchers' letters and message files, the yardmasters' log books at the Yuma, Tucson and Lordsburg terminals, and all other necessary records were gathered and placed at the disposal of the dispatchers, who were relieved of other duties and gathered together as a working party for a period of several months. The redispatching work was then performed directly from the original train-sheet records of the actual movements.

Sines, R. 1402-1403, 1426-1427.

The work was done with great care and accuracy; the methods were sound; the assumptions reasonably made were wholly justified; and the results are unimpeachable. *All of the underlying records, together with the working papers, including the redispatched train sheets and the white work sheets (Exhibit 198, R. 3115) upon which were recorded, side by side, the actual and redispatched movements, were tendered to and accepted by the appellee's counsel, for examination and study, and were retained (and presumably, closely studied) by them for substantial periods; but no opposing testimony was offered, challenging in any way the accuracy, as to either detail or result, of the redispatching studies, or criticizing the soundness of the methods employed.* No serious question was raised during the trial as to any of the assumptions necessarily made for the purposes of the studies. *It may properly be said that, in so far as its methods, details and*

mathematical results are concerned, the redispatching studies rest upon a secure and unshaken foundation, and stand unchallenged in the record.

Appellee's counsel have suggested, however, that the redispatching studies should be regarded as purely imaginary, in that the redispatched trains were never operated except "on paper"; that consequently no worthwhile showing of actual results is possible. We doubt whether this criticism was seriously intended; in any event, it was properly regarded by the trial court as entirely without merit. The redispatching studies are no more imaginary than any other reliable calculation which results from the use of standard methods, and is made by experienced and qualified experts, who base their conclusions upon careful surveys of all of the relevant factors.

The long-train operating practice is not imaginary or merely potential. It has been developed by the appellant, in common with practically all of its competitors and connections; and it is now followed on every part of the appellant's system, except in Arizona and the immediately adjacent territory. Appellant's officers, particularly the men who made the redispatching studies, are fully familiar with long-train operations, the methods by which they are carried on, and the results which follow. It required no effort of the imagination for them to apply their knowledge in order to reconstruct the handling of a known and definite movement of traffic, as to which a complete and continuous record was available, when all of the conditions governing the movement were either known, or capable of being readily determined from broad experience.

Many situations comparable to those presented by the redispatching studies can be thought of; the following may serve as an example:

Suppose an individual owns several office buildings, located in various parts of the same city. All of these buildings, except one, are of 10 stories or more; one is limited to 7 stories, because of a local ordinance. All have been designed by the same architect and built by the same contractor. The owner wishes to find out the cost of adding 3 stories to his 7-story building in the event the ordinance should be repealed or set aside, and whether, from the standpoint of income and operating costs, the outlay would be justified. He calls in the architect and contractor, asks them to prepare plans and estimates, and draws upon his operating and income experience with all his buildings. Could such an estimate be called unreliable or imaginary, or an unsatisfactory foundation for a decision by the owner as to the practicability of the proposed investment? On the contrary, men in every-day transactions use such estimates as the bases of their business decisions. In fact, municipal zoning ordinances, which are nothing more than police-power regulations of the same character as claimed for the Train-Limit Law, have been set aside or modified, largely or entirely upon the basis of showings by property owners of contemplated uses not permitted by the challenged ordinances, and consequent deprivations, measured in money; although no buildings had actually been constructed on the lands affected.

The redispatching studies are nothing less than careful surveys of the changes in operating methods which will follow if the restrictions are removed, and determinations

of the results thereof, based upon the application of known factors and actual experience to known and determined movements of traffic. They are at least as accurate as would be the study and estimate of the costs of construction and operation of the addition to the 7-story building, above cited for the purposes of illustration, and equally above the criticism or suggestion of being imaginary.

It is important to note that while the redispatching studies represent weeks and even months of detailed study and analysis by the individuals who participated in and presented them to the trial court, the basic problems were, nevertheless, comparatively simple. Essentially, the studies are comparisons between train operations, with the maximum lengths permitted by the law, and operations with maxima of 100 or 125 freight cars, and whatever convenient number of passenger cars might be required. It is beyond controversy, and indeed obvious without analysis, that the handling of the same quantity of traffic in longer trains will result in fewer train miles and train interferences, and less operating expense. While the redispatching studies may appear to be complicated, in that the review of a multitude of details was required, they are really quite simple; for they involve only the four basic arithmetical operations: (1) *dividing* a given amount of traffic into short trains, and again into long trains; (2) *adding* the number of train miles thus required; (3) *multiplying* the train miles by known costs, and aggregating the separate costs, so as to produce a lump sum for each method of operation; and (4) *subtracting* the total for one method from the total for the other. All of these are elementary

operations, with which opposing counsel have no quarrel, and in fact could not quarrel.

It may also be pointed out that in so far as the redispatching study involves the determination of the additional train service required by compliance with the law (or alternately the train service saved by noncompliance), or the number of interferences thus contributed, the problem was even simpler than stated, for the multiplication by unit cost factors became unnecessary.

The redispatching studies present probably less favorable results, and thus a lower estimate of the savings in train service and expense, than would actually be realized. For example, in the 1938 redispatching study, all delays due to locomotive defects, which occurred in actual operation, were also taken into account and assigned to redispatched trains; although a considerably less number of redispatched trains were operated, and fewer locomotives were used, with consequent less opportunity for the occurrence of locomotive failures. Again, the times allowed for inspections of the redispatched long trains by train crews were substantially greater than actually used in corresponding inspections of short trains. No saving in time or delay was assumed for the redispatched trains on account of assumed non-occurrence of accidents or casualties occurring in connection with the starting and stopping of trains although obviously with the fewer and longer trains, there would be much less starting and stopping and much less opportunity for such accidents. On the contrary, all starting and stopping accidents, and all delays incident thereto, which occurred on short trains, were

reproduced and respectively assigned to redispatched long trains, operating at or near the places and times of the short trains on which such delays occurred. No account was taken, in the redispatching studies, of any savings in yard or terminal expense which might accrue from the operation of fewer and longer trains; although it is apparent that with long-train operation, trains would undergo much less switching and reconsisting at Yuma and Lordsburg than with short-train operation. No account was taken of the considerable saving in switching operations of passenger trains at Yuma and El Paso, although again it is obvious that such switching expense would largely be saved with long passenger-train operation, although now occurring frequently where trains have to be readjusted to the 14-car limitation. It is clear that the results of redispatching studies are at least conservative, and understate rather than overstate the savings in train service, expense, delay, and interference which would follow if the restrictions of the law were removed.

Sines, R. 1420-1428, 1448-1450, 2234.

We have referred above to the fact that the redispatching studies follow methods previously employed in both the *First Arizona Train-Limit Case* and the *Nevada Train-Limit Case*. The studies in those cases were conducted largely in the same manner as in the instant case: that is to say, under the direct supervision of a member of the executive staff, the actual work of redispatching the trains being performed by the chief train dispatchers having jurisdiction over the operating divisions and subdivisions affected or threatened to be affected by the Arizona

and Nevada laws. The Arizona redispatching studies received the favorable comment and approval of the United States District Court for Arizona; that court having said in part, in its final opinion in that case (2 Fed. Supp. at p. 862):

> "The financial burden imposed upon the plaintiff by the Arizona law is another important question. * * * The bill of complaint of the Southern Pacific Company alleges that its cost study shows that by long train operation on its main line between Indio, California, and El Paso, Texas, via Maricopa and Lordsburg, their freight train expenses could be reduced over $400,000.00 annually. * * * Vaile S. Andrus, assistant to the Vice President, conducted the Southern Pacific study, and the evidence shows that * * * (he) * * * has had vast experience in that line of work. (He) prepared work sheets containing 33 items necessary to be considered in making a careful estimate, including tonnage, number of cars in the various trains, time of departure and arrival and mileage traveled by all locomotives in connection with the movement of traffic. Timekeepers inserted the wage information called for by the work sheets, including wages of engine men on train engines, double-header engines, helper engines while double-heading and wages of train men. There is also an estimate of fuel consumption and many other factors. * * * The showing of estimated savings for the Southern Pacific Company is $417,858.81. These estimates seem to be accurate and reliable and to fully justify and establish the allegations of the bills on this question."

In the findings adopted by the United States District Court for Nevada, in the *Nevada Train-Limit Case*, that

Court, in referring to the Nevada redispatching study, said in part:

> "* * * The redispatching study was carefully conducted under the direct supervision of experienced and qualified operating and executive officers of the plaintiff, by chief train dispatchers who now and for many years past, have supervised the operation and movement of plaintiff's trains on the Nevada lines. The result of this study presents as accurate a determination as possible of the effects of the law in the following particulars: (1) in requiring additional train service to be operated by plaintiff on the Nevada lines; (2) in creating or aggravating delays to and interference with plaintiff's trains and cars and the traffic transported therein; and (3) in imposing additional expense upon plaintiff's operations."

(b) INTERFERENCE WITH AND DELAYS TO INTERSTATE TRAFFIC (R. 3953-3962).

The question whether the law causes and creates delays to and interferences with the handling of traffic and movement of trains upon appellant's lines in the affected territory is one of the important issues of the case. It is presented by the allegations of paragraphs 3(f) and 3(h) (R. 13-15), and 6 (R. 22-23), of Part III of the answer.

Appellant's showing upon this issue was very complete; on the other hand, appellee offered but little testimony having any bearing thereon, and that testimony tends to confirm appellant's showing.

The delays to and interferences with the traffic and the trains handled in the affected territory are of three kinds. As enumerated in the findings they are: (1) interferences with and delays to cars and trains at terminals, principally at points outside of or at the boundary of Arizona, at which trains moving toward Arizona are reduced to sizes conforming to the law, and trains moving from Arizona built up, from 70 cars or less to the greater lengths prevailing in the adjoining states; (2) delays to individual cars, as distinguished from trains, at terminals and other stations; and (3) interferences with and delays to trains while en route, due principally to the increased number of meets and passes created by the operation of the increased number of trains compelled by the law.

(1) Terminal delays (R. 3953-3957):

The nature and character of terminal delays occasioned by the law are set forth in considerable detail in the subparagraph of this finding which carries the above title.

The evidence cited in the finding, relating to delays incurred at points on the boundary of or just outside of Arizona for the purpose of reducing or building up trains, shows that these operations are performed at Yuma on the west, and Lordsburg and Rodeo on the east; except that in many cases, particularly where passenger trains are involved, such trains are made up and broken up at El Paso, on the east. It is immaterial, however, whether these operations be actually performed at the stations mentioned, or at some other stations either nearer to the boundary line on the east or beyond the boundary line on the west. The reasons for selecting Yuma, Lordsburg

and Rodeo, in the case of freight trains, as the points of make-up and break-up of trains are simply that the yard and other facilities required exist at those points.

The reasons that El Paso is the point of make-up or break-up of passenger trains to or from Arizona are twofold. First of all, it is a terminal point where the facilities exist; second, it is a junction point of the lines through Lordsburg and Douglas, so that cars from a westward train which exceeds the limit can, in some cases, be shifted to another westward train proceeding over the alternate route, thereby avoiding at times the operation of extra sections. Similar considerations govern in the case of eastbound passenger trains.

The construction of a terminal nearer to the state line than Lordsburg, if not impracticable because of topography, would at least be difficult and expensive; moreover, the operation of a terminal at the state line would entail serious difficulties because of the grade (approximately 1.4 per cent) at the point where the Tucson-Lordsburg line crosses the boundary.

The delays incident to making up and breaking up trains are not so directly associated with the points at which the operations take place, as with the character and extent of the operations required. These delays are not avoided by shifting the scene of the operations; they are necessarily and inevitably the result of the compulsion of the law, in that trains entering Arizona must be reduced to the permitted size before they proceed across the state, while those leaving or about to leave the state must, as a matter of economic necessity and in order to avoid addi-

tional expense and train interferences, be brought up to the larger sizes which make for efficient and economical operation.

It is especially to be noted that appellee has not asserted that the methods of operation now followed by appellant, and dealt with at length in the testimony and in this portion of the findings, are not proper and economical; that is to say, appellee does not contend that the most efficient, economical, and logical method of complying with the law is to follow the present long-train method of operation in the adjoining states, and to bring long trains approaching Arizona as near to the boundary as practicable before reducing them, while building up trains which have left Arizona into long trains as soon as possible.

It will be noted, and indeed the finding emphasizes, that the delays and interferences incident to observance of the law in connection with freight trains approaching Arizona from the east, or leaving Arizona at the eastern boundary line, are experienced at points outside of the state; in other words, that all such delays and interferences are extra-territorial. Similar extra-territorial effects are avoided at the westerly boundary only because appellant has for many years followed the practice of operating its long freight trains into and out of Yuma, and there performing the reconsisting operations, even though the yard at Yuma is well within the boundary of Arizona. Appellee's counsel appear, in effect, to concede that this is the logical and proper method of operation, and that the law could be complied with otherwise, only

by running short trains over the lines west of Yuma, to and from some station where they might be reduced or built up in the same manner as presently followed at Yuma (R. 1918). To follow such a method would, of course, transfer the delays to a point outside of Arizona, and thus give the law extra-territorial effects similar to those experienced at Lordsburg, Rodeo and other stations east thereof; but it could not conceivably eliminate or even reduce the delays at all. The burden of extra-territorial expense imposed by the law would, of course, also be materially increased over and above what is now experienced, as set forth in subparagraph (b) of this finding.

We ask the Court to note particularly that the delays to trains and cars incurred at Lordsburg and points east thereof, as set forth in the subdivision of this finding carrying that sub-heading, are wholly extra-territorial and can be avoided, in so far as eastbound trains are concerned, only if the 70-car restriction is observed for the entire 171 miles between Cavot and El Paso. In practice, and because the great preponderance of the eastward trains arriving at Lordsburg contain perishable freight and, in many instances because of schedule requirements, cannot be held at that point for consolidation, a large proportion of the trains arriving from the west at Lordsburg with 70 cars or less are run through Lordsburg, and all the way to El Paso, without being built up.

Cars intended for westbound movement into or across Arizona, particularly refrigerator cars which at times are urgently required, are nevertheless delayed at Lordsburg

and points east thereof, solely because trains must be reduced to 70 cars at that point, and the surplus cars held to await movement on following trains. It frequently happens that space is not available on trains immediately following, and special trains must be run when locomotives and crews are available at Lordsburg. At times the storage space at Lordsburg available for these empties is completely filled; in which event the cars are stored at Deming or Strauss, N. M., or even at El Paso, until such time as they can be moved in trains conforming to the Arizona restriction. These delays are, of course, wholly extra-territorial in character, and emphasize the widespread effect of the law.

Sines, R. 66-69, 1721-1723, 1795-1797, 2076-2082, 2246-2247; *Baker*, R. 1294-1295, 1305-1307; *Herrell*, R. 1493-1497; *Herbert*, R. 2070-2075.

Exhibits 1 (R. 2851), 175 (R. 1284), 185 (R. 3077), 215 (R. 3199), 297 (R. 3426).

(2) Delays to trains en route: Meets and passes (R. 3957-3958):

Meetings and passings of trains are necessary incidents of train operation and they cause delays to the trains involved or at least some of them; for when a meet or pass occurs between two trains, one of the two must take siding, and occasionally it must wait, after clearing the main track, for a considerable time until the other train has either arrived or left. Naturally, however, an effort is made by appellant's operating officials to reduce delays at meetings and passing points to the minimum. Apart from the mere factor of delay, meets and passes are a source of hazard to trainmen, because

of the additional stops, and the necessity of mounting and dismounting trains while in motion in order to open or close switches.

In fact, at least one of appellee's witnesses agreed that the most desirable operation occurs when a train is able to proceed from terminal to terminal, with as few stops for meets or passes, or other purposes, as possible.

Ash, R. 2596; *Durnil*, R. 2372-2376.

The Train-Limit Law causes the numbers of meets and passes to be greatly increased, simply because it compels a substantially greater number of trains to be operated. An increase in the number of trains increases the number of meets and passes involved in the operation, not merely in direct proportion to the increase, but practically in proportion to the square of the total number of trains.

The formula which determines the number of meets and passes which will occur in conjunction with operations over a particular district (as, for example, between Yuma and El Paso via Gila, Tucson and Lordsburg) is capable of mathematical determination; and in this case that formula was carefully and accurately determined for the district just mentioned, by means of a series of computations predicated upon actual operations as shown on the original dispatcher's train sheets. Applied to the instant case, the formula gives the following results: The operation of 4,304 additional freight trains, during the year 1938, over the principal main line between Yuma and El Paso via Gila and Lordsburg, which additional trains were run solely because of the restrictions of the

law and would have been eliminated if the law were not in effect, created about 16,500 additional meets and passes, which would not have occurred if long-train operation had prevailed; or, alternately expressed, an increase of about 28.4 per cent over and above the number of trains (both freight and passenger), which appellant would have run if it had not been for the law, caused an increase in the total number of meets and passes, between all trains operated, amounting to about 63.0 per cent.

Exhibits 220 (R. 3210), 298 (R. 3427).

The effect of the increased number of trains, in the way of added train interferences due to the greater number of meets and passes, is shown graphically upon the chart of train movements received in evidence as Exhibit 220. This exhibit traces the movement of every freight and passenger train operated on the Yuma-Gila-Lordsburg-El Paso line during the twenty-four hours, midnight to midnight, on June 18, 1938; that day being selected because it was the day of heaviest movement in June, 1938, which month was, in turn, the month of heaviest traffic volume in that year. Side by side with the chart of actual movement, upon that exhibit, are charted the trains operated during the same twenty-four hour period, as they appear on the redispatched train sheets of the redispatching study. Although this exhibit was the subject of considerable cross-examination by appellee's counsel, who were also furnished the underlying data from which the exhibit was made, and in fact retained that material in their possession for some time, no opposing testimony was adduced, nor was the essential accuracy of the exhibit challenged, except in minor details.

Appellee's counsel affected to regard our exhibits and testimony relative to the increased number of meets and passes as speculative and theoretical, apparently believing that the computations thereby presented to the Court were of little value. These computations, and the results therefrom submitted to the Court, present a purely mathematical calculation based upon a series of observations, from which is deduced a precise mathematical formula. That formula is no more speculative or theoretical than any other natural mathematical law: for example, the mortality tables, upon which are based the fundamental calculations of the life-insurance companies; the experience tables of fire and casualty insurance companies; the basic formulae used in the highly accurate science of naval gunnery; the formulae relative to the flow and measurement of water; or the formula representing the law of gravity. It is no more difficult for a competent engineer or mathematician to calculate the formula which will represent the normal and expected incidence of the meets and passes for a particular district or territory, given an adequate number of observations on which to base that calculation, than for the same or a similarly competent engineer or mathematician to calculate any other formula which he may need as to the strength, behavior, or occurrence, of natural phenomena; provided only a sufficient number of observations have been made. Since there is no question in this case as to the competency of the engineer who made the calculations, nor the adequacy of the observations taken from actual experience, the correctness of the result is not open either to challenge by appellant's counsel or to the suggestion or inference that it is speculative.

It is quite true that the mathematical method of calculating as closely as possible the exact number of additional meets and passes created by compliance with the law employs an analytical process with which the ordinary layman is not familiar; and this very fact may have influenced opposing counsel and inspired their suggestions. Nevertheless the basic principle remains, and is not challenged in any way, that an increase in the number of trains operated brings about a disproportionately greater increase in the number of meets and passes, with the attendant delays, interferences and hazards. Therefore, even giving every effect to counsel's criticism, there is still no avoidance of the result that the operation of the additional trains compelled by the law (and we emphasize that the undoubted effect, if not the outspoken purpose, of the law is to compel such additional operation) brings about a very much larger increase in the number of meets and passes. Whether this increase is 16,500, on the principal main freight line via Gila and Lordsburg, because of the operation of 4304 additional trains, or as few as 10,000 or as many as 20,000, is perhaps unimportant; the important fact is that the law necessarily creates these additional delays, interferences and hazards, although they could readily be avoided by removing the restrictions on the train lengths, and thus reducing the number of trains operated.

Herbert, R. 1341-1342; *G. C. Baker*, R. 1463; *Sines*, R. 1731-1745, 2086-2090, 2231-2234, 2281-2282; *Durnil*, R. 2375-2377; *Menzies*, R. 2819.

Exhibits 220 (R. 3210), 226 (R. 3215), 298 (R. 3427).

(3) Delays to and interferences with passenger trains and traffic (R. 3959-3960):

The finding carrying the above sub-heading is predicated upon the elaborate studies of trains and traffic introduced as Exhibit 199 (R. 3116), as supplemented by the supporting oral testimony and certain other exhibits.

The delays to and interferences with passenger trains and traffic are much more widespread, and particularly experienced to a much greater degree outside of Arizona, than in the case of freight traffic. The very nature of passenger traffic renders these results inevitable, and they are accentuated by the fact that the limitation (14 cars) is so comparatively small. It is not possible, in passenger-train operation, ordinarily to set out excess cars at a station at or near the state boundary with the purpose of having them moved on some following train; nor is it possible ordinarily to stop short trains at or near the state boundary for the purpose of consolidating with other trains. Such set-outs and consolidations, if made, must be at points such as El Paso or Yuma, where alternate routes converge and other passenger trains are available to handle the excess cars. If set-outs are made at points or at times where other trains having capacity to handle the excess cars are not available, extra sections must be made up and run, thus contributing additional train interferences and possible delays. Necessarily, the operations of reswitching trains at points where cars are set out or picked up involve delays, not only to the trains themselves, but in even greater degree to the cars.

It also sometimes happens that cars at intermediate points such as Phoenix or Tucson, and occasionally Yuma, intended for movement in particular passenger trains, must be left behind to follow on some other train, or handled as a special movement, solely because the train in which they were intended to be handled is already at the limit when it arrives at the station. Special movements of large parties who, with their baggage and other property, occupy more than 14 cars cannot be made in single passenger-train units across Arizona; the trains must either be broken up or, as sometimes happens, the entire movement diverted to some other line (usually a competitor) which is not compelled to observe a 14-car restriction.

Mahoney, R. 1049.

The finding sets forth the detail of the various interferences taking place during the year 1938. It is shown that these interferences occurred 222 times during that year, and involved 359 trains, and that a substantial proportion of the interferences were at points outside of Arizona. The correctness of this showing was not challenged by appellee, nor was there any opposing testimony.

G. C. Baker, R. 1306-1309; *Sines*, R. 1364-1367, 1449-1450, 1517-1526, 1805-1812, 2226-2230.

Exhibits 187 (R. 3079), 188 (R. 3081), 199 (R. 3116-3148), 230 (R. 3228).

(4) Summary of effect of delays and interferences (R. 3961-3962):

The combined results of all the delays to and interferences with freight traffic caused by the law, as well as

any speeding-up which long-train operation might permit, are set forth in Exhibits 227 (R. 3217), 228 (R. 3223), 237 (R. 3235), 238 (R. 3240), 243 (R. 3248) and 244 (R. 3252), the substance of which is stated in the finding bearing the above caption. These exhibits present the results of the redispatching study for June and August, 1938, and the other redispatching studies for April, 1940. Comparing the number of trains and traffic handled in the redispatched trains with movement of the same traffic as it took place and was recorded upon the train sheets of actual movement, they demonstrate that if the law had not been in effect in 1938, and appellant had then been able to operate its freight trains free of the 70-car restriction and with the changes in power assignments, siding capacities, and other facilities contemplated in connection with the 1938 redispatching study, the scheduled and identified fruit blocks and manifest sections operated during June and August, and individual cars handled in that month, would have spent less time en route on the average between El Paso and Yuma, and arrived upon or ahead of scheduled times more frequently, and late on schedule less frequently, than was the case in actual experience with the short-train operation.

The first 1940 redispatching study, which relates to the limited long-train operation actually undertaken during the period April 4th to April 30th, 1940, shows, according to the summaries presented by Exhibits 237 (R. 3235) and 238 (R. 3240), that the redispatched short trains made slightly better times, on the average, than the actual limited long-train operation. Eastward, out of 185 blocks

and manifest sections involved, 134 made the same times as the actual; 40 made slightly better times; and 11 arrived on the average a little later. The total time gained by the 40 redispatched blocks which arrived earlier was 38 hours, 55 minutes; the total time lost by the 11 redispatched blocks which arrived later was 8 hours and 10 minutes. Of the 185 actual trains involved, however, all but five arrived at El Paso on or ahead of schedule; and only two of the five were more than 15 minutes late. Westward there were 96 blocks and manifest sections involved; all but 14 of the redispatched blocks made the same times, 8 arriving in advance of the actual, and 6 later than the actual. This comparison, it may be emphasized, was between a short-train operation in conformity with the law and a limited long-train operation, which was inevitably hampered by the absence of the adequate siding capacities necessary for satisfactory long-train operation and the non-availability of the proper types of locomotives to handle the heavier trains most efficiently. The results which would obtain, however, if long-train operation with proper facilities had been conducted in April, 1940, are shown on Exhibits 243 (R. 3248) and 244 (R. 3252). Exhibit 243 shows that out of 179 blocks and manifest sections involved, 106 made better time and only 60 made poorer time eastward than in actual operation, while out of 96 blocks or manifest sections operated eastward, 24 made better time than actual, and only 17 made poorer time. The average variation from the actual time of both those arriving earlier and those arriving later than actual was only slightly more than 20 minutes.

Sines, R. 1790-1800, 1835-1839, 1852-1857, 1868-1871.

The results shown on Exhibits 243 and 244 confirm very strongly the direct comparison between restricted operations, and long-train operations with proper facilities, as set forth on Exhibits 227 and 228. They demonstrate the truth of the allegation, found in paragraph 3(e) of Part III of the answer (R. 12), that the practice of standard long-train operation does not retard, but on the contrary expedites materially, the movement of traffic, and does not delay but on the contrary promotes and makes possible the early delivery of such traffic.

(c) REDUCTION IN TRAIN LENGTHS: INCREASE IN NUMBER OF TRAINS OPERATED (R. 3962-3966).

(1) Freight train operations (R. 3962-3965):

This finding sets forth the undisputed fact that the enforcement of the law causes and will continue to cause both the average and the maximum lengths of the freight trains operated in the affected territory to be greatly reduced, and correspondingly compels the operation of a substantially larger number of trains and necessarily a substantially greater number of train miles and locomotive miles, than would be necessary for the handling of the same total volume of traffic if it were not for the law.

The finding also contains a statement, which we again emphasize, that the effects of the law in this respect are not confined to Arizona, under the methods of operation now followed in order to comply with the law. The 70-car restriction is completely effective, and train lengths are completely controlled thereby, as far east as Lordsburg and Rodeo, New Mexico. To a large extent the law also controls the lengths of trains as far east as El Paso.

The exact extent of the effects of the law upon average train lengths is set forth graphically upon Exhibits 215 (R. 3199), 235 (R. 3232) and 241 (R. 3245). The substance of those exhibits is stated in the findings, and to avoid repetition we here reproduce the exhibits. We call especial attention to the showing of the effect of the law in the district between the Arizona-New Mexico line and El Paso.

The showing on these exhibits is based directly upon the redispatching study. The comparison on Exhibit 215 is between the average length of the trains operated during the months of June and August, 1938, and the length of the redispatched trains, shown on the redispatched train sheets and work sheets A (Exhibit 198, R. 3115), which handled the same traffic. The overall effect of the law, succinctly stated, as applied to 1938 traffic, was to cause the average length of the freight trains operated between Yuma and El Paso via Gila, Tucson and Lordsburg to be reduced from 90.1 cars per train, to 66.0 cars: a percentage reduction of 26.7 per cent (Exhibit 226, R. 3215). The comparison on Exhibit 235 is between the actual limited long-train operation of April, 1940, and a redispatched operation conforming to the law; while the showing on Exhibit 241 is between the actual limited long-train operation, and a long-train operation employing the proper facilities: that is to say, the more powerful locomotives, the longer sidings, and the other additions to permanent facilities which are referred to in Finding X(b) (R. 3948). The effect of compliance with the law in holding train lengths below the figures which would otherwise be obtained, as determined from the 1940 redispatching studies, may readily be seen by studying Exhibits 235 and 241

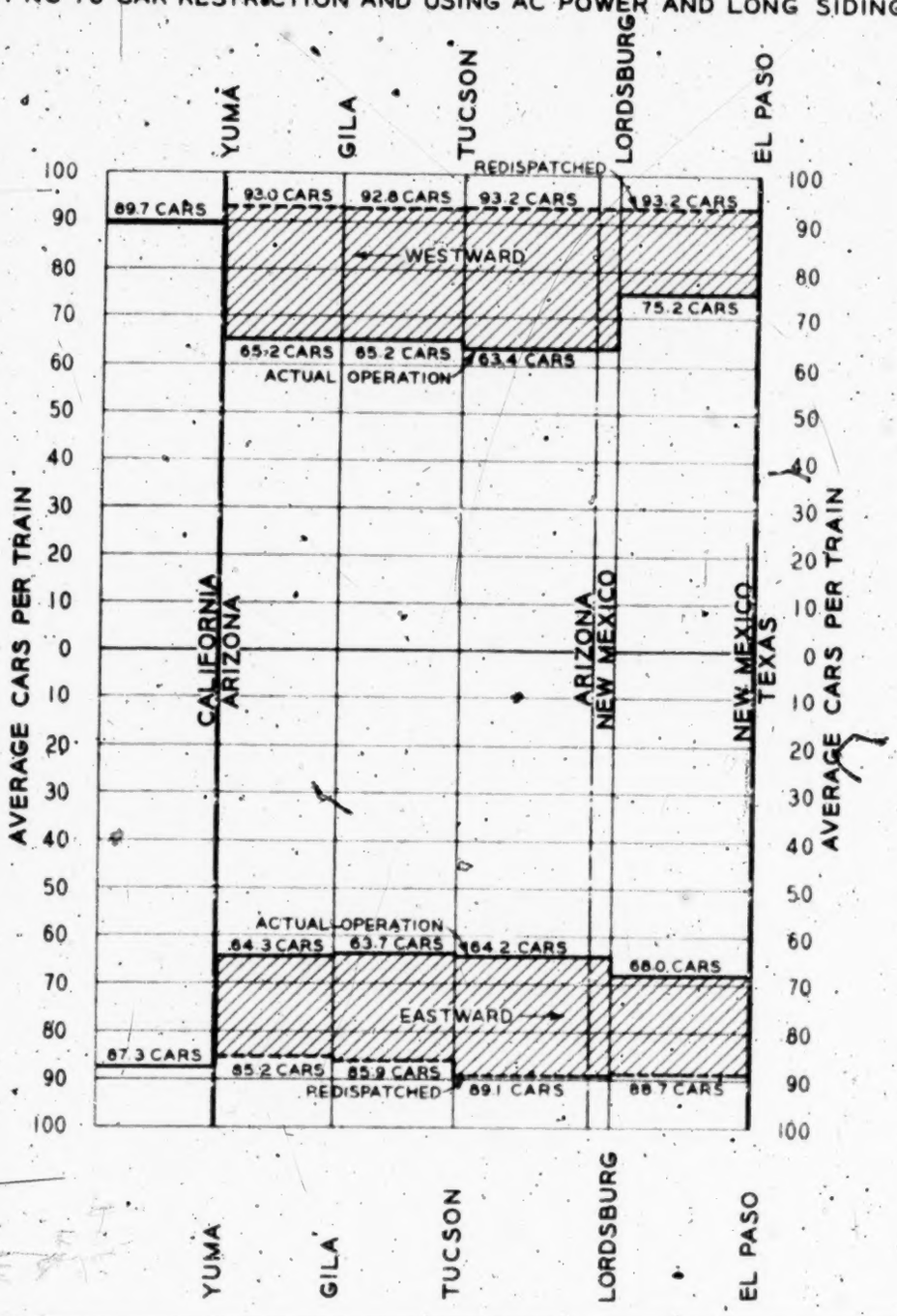
SUPERIOR COURT, PIMA CO., ARIZONA
STATE V S.P.CO. NO 20087.
DEFTS. EX. NO 215 (WITNESS _____)

SOUTHERN PACIFIC COMPANY.

RELATIVE TRAIN LENGTHS

CALIFORNIA - ARIZONA - NEW MEXICO - TEXAS.

THROUGH AND LOCAL FREIGHT TRAINS
OPERATING VIA YUMA, GILA, TUCSON, LORDSBURG AND EL PASO
EXCLUDING STRAUSS TURNAROUND TRAINS
BASED ON REDISPATCHING STUDY OF JUNE AND AUGUST 1938
WITH NO 70 CAR RESTRICTION AND USING AC POWER AND LONG SIDINGS



241

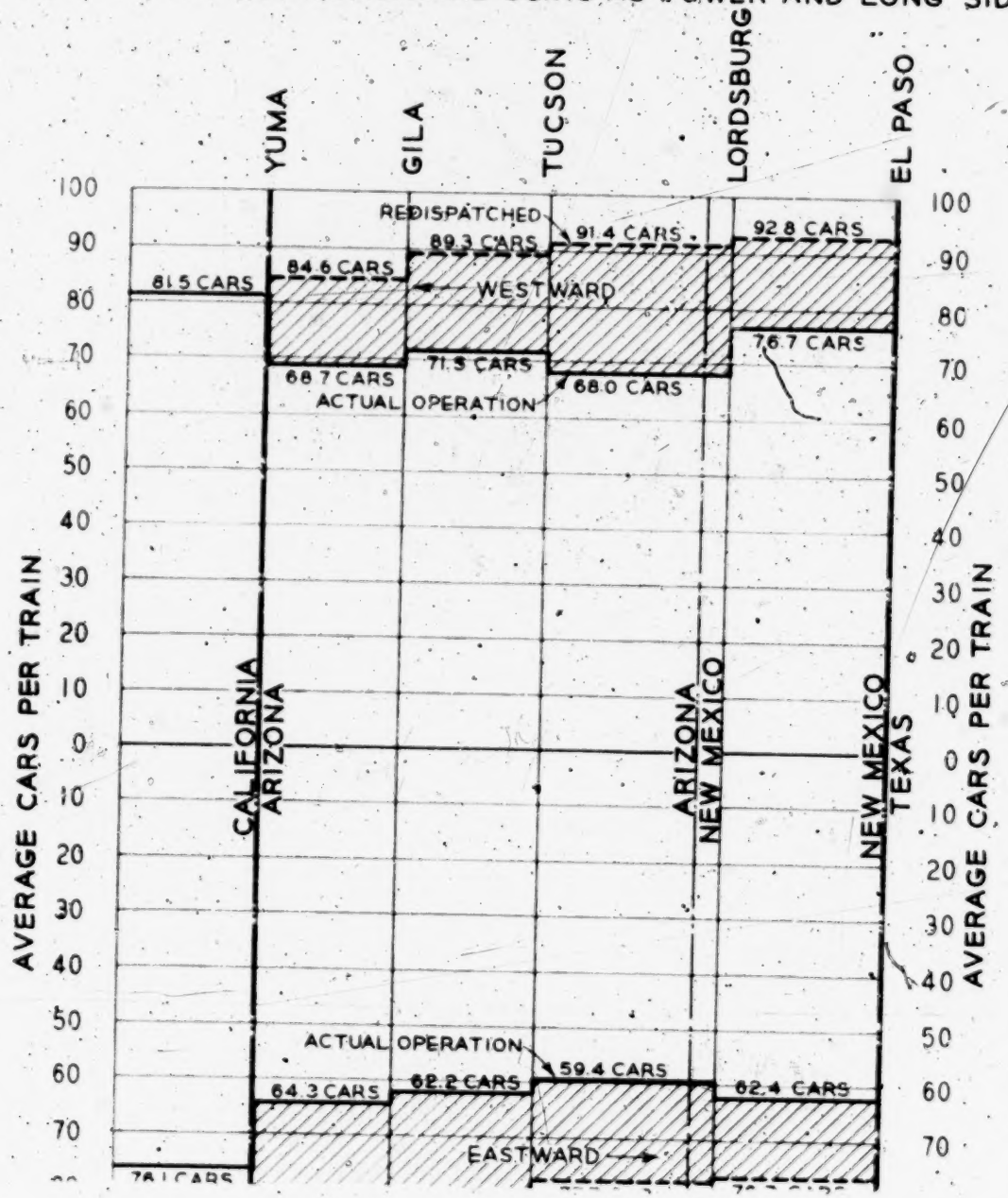
SUPERIOR COURT, PIMA CO., ARIZONA
STATE V. S.P.CO. NO 20087
DEFTS. EX. NO. ____ (WITNESS ____)

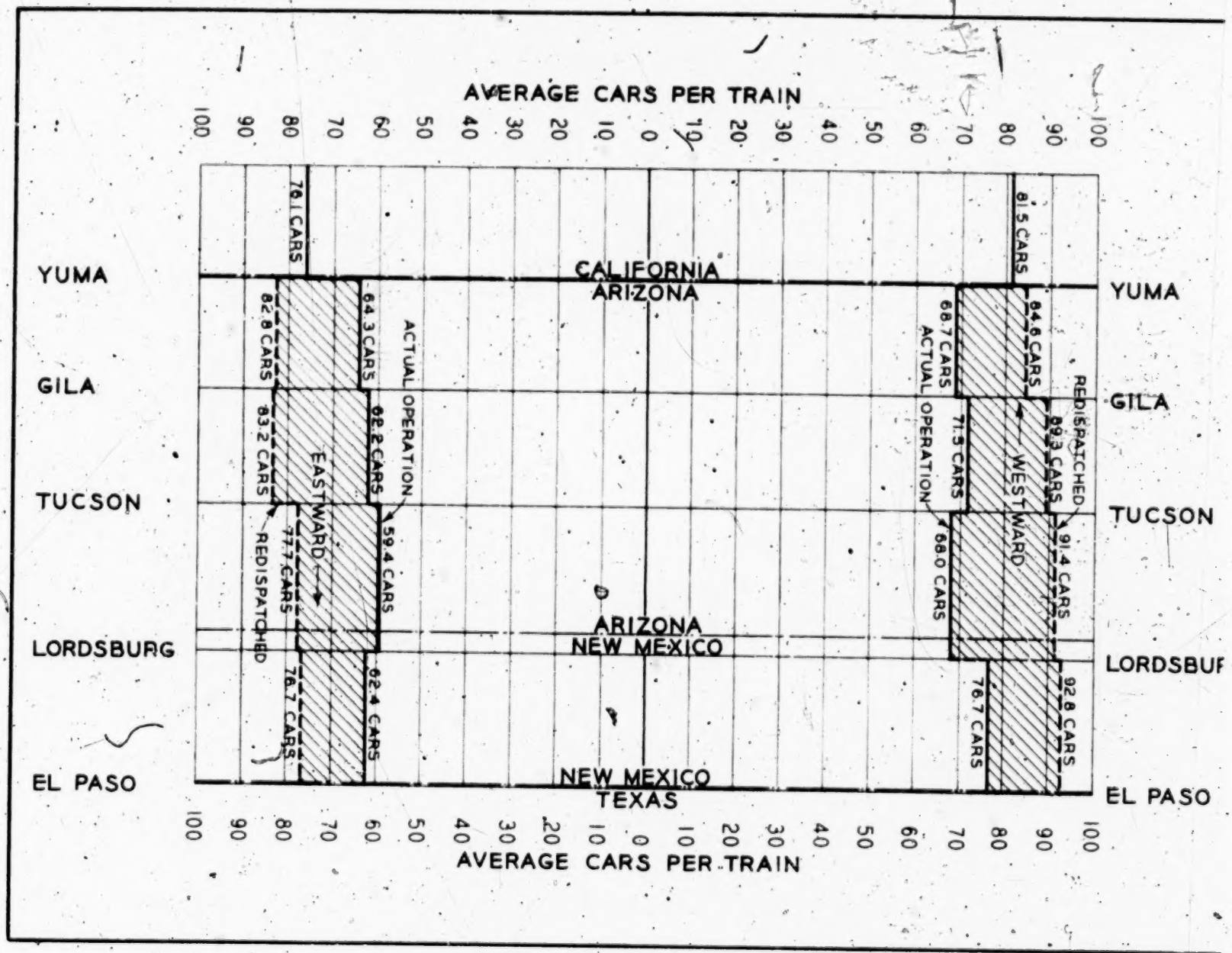
SOUTHERN PACIFIC COMPANY

RELATIVE TRAIN LENGTHS

CALIFORNIA - ARIZONA - NEW MEXICO - TEXAS.

THROUGH AND LOCAL FREIGHT TRAINS
OPERATING VIA YUMA, GILA, TUCSON, LORDSBURG AND EL PASO
EXCLUDING STRAUSS TURNAROUND TRAINS
BASED ON REDISPATCHING STUDY OF APRIL 1940
WITH NO 70 CAR RESTRICTION AND USING AC POWER AND LONG SIDINGS




AVERAGE CARS PER TRAIN
100 90 80 70 60 50 40 30 20 10 0 10 20 30 40 50 60 70 80 90 100
YUMA
GILA
TUCSON
LORDSBURG
EL PASO
CALIFORNIA
ARIZONA
ARIZONA
NEW MEXICO
NEW MEXICO
TEXAS
79.1 CARS
82.8 CARS
83.2 CARS
77.7 CARS
78.7 CARS
64.3 CARS
62.2 CARS
59.4 CARS
62.4 CARS
ACTUAL OPERATION
EASTWARD
REDISPATCHED
81.5 CARS
84.6 CARS
89.3 CARS
91.4 CARS
92.8 CARS
68.7 CARS
71.5 CARS
68.0 CARS
78.7 CARS
ACTUAL OPERATION
WESTWARD
REDISPATCHED
YUMA
GILA
TUCSON
LORDSBUF
EL PASO
AVERAGE CARS PER TRAIN

together. It will be observed that the figures representing actual operations, and the graphic representations of the actual operations, are identical in both exhibits.

The effect of the law, as it appears from the 1940 studies, is also shown on Exhibits 236 (R. 3233) and 242 (R. 3246). From these two exhibits, taken together, it appears that for the 27 days of April, 1940, the average train lengths between Yuma and El Paso via Gila and Lordsburg, if the law had been complied with, would have been 64.4 cars; whereas if long-train operation with larger locomotives and longer sidings had been undertaken the average train length would have been 85 cars: so that the reduction incident to compliance would have been 20.6 cars, or 24.3 per cent.

If the law had not been in effect during 1938, appellant could and would have handled the traffic which moved over the main line between Yuma and El Paso via Gila and Lordsburg and over the alternate line between Tucson and El Paso via Douglas with 4304 fewer freight trains. The actual additional operation caused by the law, expressed in train miles and locomotive miles, is shown on Exhibit 226 (R. 3215). Based upon the study of two months' operations, and expanding the figures by the appropriate ratio, it appears that the additional train miles required by the law amounted to 638,569; the additional locomotive miles to 798,424. Expressed in percentage, the law compelled appellant to operate 30.8 per cent more freight trains, and produce 33.1 per cent more freight-train miles, and 35.9 per cent more freight-locomotive miles, than would otherwise have been required. The additional

locomotive miles are somewhat greater in number than the additional train miles, because of helper-engine and light-engine movements which accumulate locomotive miles, but not train miles. For ready reference, particularly as showing the substantial proportion of the additional operation compelled by the law in the territory east of Lordsburg and Douglas, we here reproduce Exhibits 226, 236 and 242:

The showing on Exhibit 226 relates to the year 1938, as stated; but the accuracy of the showing thereon can readily be confirmed by examination of Exhibits 236 and 242. Those exhibits show that for the 27-day period short-train operation in compliance with the law would have required the running of 378 more trains than if "unrestricted" long-train operation had prevailed; the additional train miles produced would be 56,182, and the additional locomotive miles 74,329. The 27 days from April 4 to April 30, inclusive, represent a little more than 1/13th of all the days of the year 1940; and an approximation of the total amount of the annual savings by unrestricted operation can therefore be obtained by multiplying the figures for the 27-day period by 13. On this basis appellant would have saved approximately 5,000 trains, about 700,000 train miles, and about 900,000 locomotive miles, as compared to short-train operation, if it had followed unrestricted operation throughout the year 1940.

Sines, R. 1846-1852.

We ask the Court to note particularly the statement in the finding that 151,789 of the additional freight-train miles which the law compelled in 1938, or 23.8 per cent of

Superior Court, Pima Co., Arizona
State v. S.P.Co. No. 20087

Defts. Ex. No. _____ (Witness _____)

(Sheet 1 of 2 sheets)

SOUTHERN PACIFIC COMPANY
(Pacific Lines)

REDISPATCH STUDY - OPERATING STATISTICS
YUMA, ARIZONA TO EL PASO, TEXAS
EXCLUDING PHOENIX LINE
FOR PERIOD JUNE AND AUGUST, 1938

	NUMBER OF TRAINS (a)	TRAIN MILES (b)	OTHER LOCOMOTIVE MILES (c)	TOTAL LOCOMOTIVE MILES (d)	NUMBER OF CARS (e)	CARS PER TRAIN (f)
NORTH LINE						
I - Yuma - Gila						
Actual	771	94,833	4,223	99,056	49,940	64.8
Redispatch	554	68,165	1,878	69,843	49,373	89.1
Saving for period	217	26,668	2,345	29,213	(1) 567	24.3
II - Gila - Tucson						
Actual	767	98,176	16,518	114,694	49,468	64.5
Redispatch	550	70,400	10,746	81,146	49,178	89.4
Saving for period	217	27,776	5,772	33,548	(2) 290	24.9
III - Tucson - Lordsburg						
Actual	756	123,010	60,878	183,874	48,240	63.8
Redispatch	521	85,079	39,418	124,497	47,499	91.2
Saving for period	235	37,931	21,457	59,377	(3) 741	27.4
IV - Lordsburg-El Paso (Through trains only)						
Actual	674	100,084	563	100,647	48,255	71.6
Redispatch	521	77,335	1,728	79,063	47,399	91.0
Saving for period	153	22,749	(1) 1,165	21,584	(4) 856	19.4
V - El Paso-Strauss (Turnaround trains only)						
Actual	4	68	-	68	200	(5) 100.0
Redispatch	56	952	-	952	2,800	(5) 100.0
Saving for period	(1) 52	(1) 884	-	(1) 884	(1) 2,600	
VI - TOTAL NORTH LINE						
Actual	2,972	416,171	82,179	498,339	196,103	(6) 66.0
Redispatch	2,802	301,931	53,570	355,501	196,249	(6) 90.1
Saving for period	770	114,240	28,609	142,838	(1) 146	24.1
SOUTH LINE						
VII - Tucson - Douglas						
Actual	121	15,128	-	15,128	5,958	48.8
Redispatch	122	15,128	-	15,128	6,876	56.4
Saving for period	-	-	-	-	(7) 918	7.6
VIII - Douglas-Bisbee Jct. (Turnaround trains only)						
Actual	52	1,208	-	1,208	2,851	54.8
Redispatch	52	1,208	-	1,208	3,082	59.3
Saving for period	-	-	-	-	(8) 231	4.5
IX - Douglas - El Paso						
Actual	122	26,596	-	26,596	5,865	48.1
Redispatch	122	26,596	-	26,596	6,763	55.4
Saving for period	-	-	-	-	(9) 898	7.3
X - TOTAL SOUTH LINE						
Actual	296	42,932	-	42,932	14,674	(10) 48.5
Redispatch	296	42,932	-	42,932	16,721	(10) 56.9
Saving for period	-	-	-	-	(1) 2,047	7.4
XI - TOTAL NORTH AND SOUTH LINES						
Actual	3,268	459,103	82,179	541,271	210,777	(11) 64.7
Redispatch	2,498	344,863	53,570	398,433	212,970	(11) 85.6
Saving for period	770	114,240	28,609	142,838	2,193	21.9
XII - PER CENT CHANGE, SAVING vs. ACTUAL	23.6%	24.9%	34.8%	26.4%	-	33.8%
XIII - SAVING FOR YEAR (Saving for period						

REDISPATCH STUDY - OPERATING STATISTICS
YUMA, ARIZONA TO EL PASO, TEXAS
EXCLUDING PHOENIX LINE
FOR PERIOD JUNE AND AUGUST, 1938

	NUMBER OF TRAINS (a)	TRAIN MILES (b)	OTHER LOCOMOTIVE MILES (c)	TOTAL LOCOMOTIVE MILES (d)	NUMBER OF CARS (e)	CARS PER TRAIN (f)
NORTH LINE						
I - Yuma - Gila						
Actual	771	91,833	4,223	99,056	49,940	64.8
Redispatch	554	68,166	1,678	69,843	49,373	89.1
Saving for period	217	26,668	2,545	29,213	(1) 567	24.3
II - Gila - Tucson						
Actual	767	98,176	16,518	114,694	49,468	64.5
Redispatch	550	70,400	10,746	81,146	49,178	89.4
Saving for period	217	27,776	5,772	33,548	(2) 290	24.9
III - Tucson - Lordsburg						
Actual	756	123,010	60,875	183,874	48,340	63.8
Redispatch	521	83,079	39,418	124,497	47,499	91.2
Saving for period	235	37,931	21,457	59,377	(3) 741	27.4
IV - Lordsburg-El Paso (Through trains only)						
Actual	674	100,084	563	100,647	48,255	71.6
Redispatch	521	77,335	1,728	79,063	47,399	91.0
Saving for period	153	22,749	(1) 1,165	21,584	(4) 856	19.4
V - El Paso-Strauss (Turnaround trains only)						
Actual	4	68	-	68	200	(5) 100.0
Redispatch	56	952	-	952	2,800	(5) 100.0
Saving for period	(1) 52	(1) 884	-	(1) 884	(1) 2,600	
VI - TOTAL NORTH LINE						
Actual	2,972	416,171	83,179	498,339	196,103	(6) 66.0
Redispatch	2,802	301,931	53,570	355,501	196,249	(6) 90.1
Saving for period	770	114,240	28,609	142,838	(1) 146	24.1
SOUTH LINE						
VII - Tucson - Douglas						
Actual	127	15,128	-	15,128	5,958	46.8
Redispatch	122	15,128	-	15,128	6,876	56.4
Saving for period	-	-	-	-	(7) 918	7.6
VIII - Douglas-Bisbee Jct. (Turnaround trains only)						
Actual	52	1,208	-	1,208	2,851	54.8
Redispatch	52	1,208	-	1,208	3,082	59.3
Saving for period	-	-	-	-	(8) 231	4.5
IX - Douglas - El Paso						
Actual	123	26,596	-	26,596	5,865	48.1
Redispatch	122	26,596	-	26,596	6,763	55.4
Saving for period	-	-	-	-	(9) 898	7.3
X - TOTAL SOUTH LINE						
Actual	296	42,932	-	42,932	14,674	(10) 48.5
Redispatch	296	42,932	-	42,932	16,721	(10) 56.9
Saving for period	-	-	-	-	(1) 2,047	7.4
XI - TOTAL NORTH AND SOUTH LINES						
Actual	3,268	459,103	83,179	541,271	210,777	(11) 64.7
Redispatch	2,498	344,863	53,570	398,433	212,970	(11) 85.6
Saving for period	770	114,240	28,609	142,838	2,193	21.9
XII - PER CENT CHANGE, SAVING vs. ACTUAL	23.6%	24.9%	34.4%	26.4%	-	33.8%
XIII - SAVING FOR YEAR (Saving for period increased in ratio of 17.89% to 100%)	4,304	638,569	159,918	798,424	-	-

(1) - INCREASE

(1) YUMA - GILA DISTRICT: Decrease of 618 engine water cars and 25 deadhead cabooses, and increase of 70 loads which moved via Phoenix Line in actual operation and via Gila Line in redispatched operation, produces net decrease of 567 cars.

(2) GILA - TUCSON DISTRICT: Decrease of 338 engine water cars and 34 deadhead cabooses, and increase of 70 loads which moved via Phoenix Line in actual operation and via Gila Line in redispatched operation, produces net decrease of 290 cars.

(3) TUCSON-LORDSBURG DISTRICT: Decrease of 23 deadhead cabooses, 231 east empties and 642 west empties, which moved North Line in actual operation but South Line in redispatched operation, offset by an increase of 155 west empties which reached Tucson on the redispatch but which were left at Bowie on the actual, produces a net decrease of 741 cars.

(4) LORDSBURG-EL PASO DISTRICT: Decrease of 231 east empties and 642 west empties which moved North Line in actual operation but South Line in redispatched, offset by an increase of 17 deadhead cabooses in redispatched operation, produces net decrease of 856 cars.

(5) EL PASO - STRAUSS DISTRICT: Average cars per train computed for Strauss turnarounds in westward direction only (two trains in actual, and 28 trains in redispatch) as eastward trains were without cars.

(6) TOTAL NORTH LINE: Average cars per train computed, omitting El Paso-Strauss turnaround trains and cars handled by those trains.

(7) TUCSON - DOUGLAS DISTRICT: Increase of 231 east empties, and 642 west empties which moved North Line in actual operation but South Line in redispatched, plus 20 westward empties which reached Tucson on the redispatch but which were left at Douglas on the actual, plus 25 west empties which reached Tucson on the redispatch, but which were left at Rodeo on the actual in order to comply with the law, produces total increase of 918 cars.

(8) DOUGLAS - BISBEE JCT. (Turnaround trains only): Increase of 231 empties handled Douglas to Bisbee Jct., by redispatched turnaround trains to avoid helping redispatched through westward trains Douglas to Bisbee Jct.

(9) DOUGLAS - EL PASO DISTRICT: Increase of 231 east empties and 642 west empties which moved North Line in actual operation but South Line in redispatched, plus 25 westward empties which reached Douglas (and Tucson) on the redispatch, but which were left at Rodeo on the actual in order to comply with the law, produces a total increase of 898 cars.

(10) TOTAL SOUTH LINE: Average cars per train computed omitting Douglas-Bisbee Jct., turnaround trains and cars handled by those trains.

(11) TOTAL NORTH AND SOUTH LINES: Average cars per train computed omitting Strauss and Douglas-Bisbee Jct., turnaround trains and cars handled by those trains:-

ACTUAL:	4	Strauss turns with	200 cars
	52	Douglas-Bisbee Jct. turns	2,851 cars
	56	trains omitted with	3,051 cars
REDISPATCH:	56	Strauss turns with	2,800 cars
	52	Douglas-Bisbee Jct. turns	3,082 cars
	108	trains omitted with	5,882 cars

DERIVATION OF RATIO - 17.89%

	GROSS TON MILES (Thousands)	
	YEAR 1938	PERIOD JUNE AND AUGUST
Yuma - Tucson	2,644,436	482,345
Tucson - Lordsburg	1,747,285	308,788
Lordsburg - El Paso	1,556,795	279,795
Tucson - El Paso vi Douglas	457,857	75,158
TOTAL	6,406,373	1,146,086
Per Cent total period June and August to year 1938		17.890%

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State v. S.P.Co. No. 20087
Defts. Ex. No. 236 Witness B. S. SINES
(Sheet 1 of 2 sheets)

SOUTHERN PACIFIC COMPANY
(Pacific Lines)

REDISPATCH STUDY - OPERATING STATISTICS
YUMA, ARIZONA TO EL PASO, TEXAS
FOR PERIOD APRIL 4TH TO APRIL 30TH, 1940
ACTUAL OPERATION COMPARED WITH REDISPATCHED OPERATION,
OBSERVING 70 CAR RESTRICTION AND USING PRESENT POWER AND SHORT SIDINGS

	NUMBER OF TRAINS (a)	TRAIN MILES (b)	OTHER LOCOMOTIVE MILES (c)	TOTAL LOCOMOTIVE MILES (d)	NUMBER OF CARS (e)	CARS PER TRAIN (f)
NORTH LINE						
I - Yuma - Gila						
Redispatch	399	49,077	5,145	54,222	25,279	63.4
Actual	377	46,371	2,784	49,155	25,123	66.6
Increase for period	22	2,706	2,361	5,067	(1) 156	(D) 3.2
II - Gila - Tucson						
Redispatch	404	51,582	9,867	61,449	25,771	63.8
Actual	382	48,766	7,991	56,757	25,643	67.1
Increase for period	22	2,816	1,876	4,692	(2) 128	(D) 3.3
III - Tucson - Lordsburg						
Redispatch	433	70,589	31,135	101,664	26,647	61.1
Actual	413	67,378	31,384	98,702	26,376	63.9
Increase for period	20	3,211	(D) 249	2,962	(3) 71	(D) 2.8
IV - Lordsburg - El Paso						
Redispatch	378	56,134	231	56,365	26,367	69.8
Actual	378	56,134	231	56,365	26,310	69.6
Increase for period	-	-	-	-	(4) 57	.2
V - TOTAL NORTH LINE						
Redispatch	1,614	227,322	46,378	273,700	103,664	64.4
Actual	1,550	218,589	42,390	260,979	103,452	66.7
Increase for period	64	8,733	3,988	12,721	(5) 412	(D) 2.3
SOUTH LINE						
VI - Tucson-Douglas (Through trains only)						
Redispatch	71	8,803	810	9,613	3,532	49.7
Actual	71	8,803	810	9,613	3,577	50.4
Increase for period	-	-	-	-	(6)(D) 45	(D) .7
VII - Douglas-Bisbee Jct. (Turnaround trains only)						
Redispatch	48	1,050	-	1,050	3,108	64.7
Actual	48	1,050	-	1,050	3,171	66.1
Increase for period	-	-	-	-	(7)(D) 63	(D) 1.4
VIII - Douglas - El Paso						
Redispatch	59	12,426	218	12,644	2,677	45.0
Actual	57	12,426	218	12,644	2,734	48.0
Increase for period	-	-	-	-	(8)(D) 57	(D) 1.0
IX - TOTAL SOUTH LINE						
Redispatch	178	22,279	1,028	23,307	9,315	(9)66.5
Actual	176	22,279	1,028	23,307	9,482	(9)49.3
Increase for period	-	-	-	-	(D) 167	(9)(D)0.8
X - TOTAL NORTH AND SOUTH LINES						
Redispatch	1,790	249,601	47,406	297,007	113,179	(10)63.2
Actual	1,726	240,868	43,418	284,286	112,934	(10)66.4
Increase for period	64	8,733	3,988	12,721	245	(10)(D) 2.2

D - Indicates Decrease

(1) Yuma - Gila District: Increase 20 additional engine water cars east, 20 additional deadhead cabooses, 21 additional engine water cars west, and 95 west empties which moved via Phoenix Line in actual operation, and via Gila line in redispatched operation, total 156 cars.

(2) Gila - Tucson District: Increase 12 additional deadhead cabooses east, 21 additional engine water cars west, and 95 west empties which moved via Phoenix line in actual operation and via Gila line in redispatched operation, total 128 cars.

(3) Tucson - Lordsburg District: Increase, 14 additional deadhead cabooses and 57 west empties which moved via south line in actual operation and via north line in redispatched operation, total 71 cars.

(4) Lordsburg-El Paso District: Increase 57 west empties which moved via south line in actual operation and via north line in redispatched operation.

(5) Increase - sum of (1), (2), (3) and (4) in column (a) on sheet 1.

(6) Tucson-Douglas (Through trains only): Decrease account 57 west empties which moved via south line in in actual and via north line in redispatched operation, and 8 loads, 4 empties, which moved on eastward Bisbee Jct. turnaround train in actual operation and on eastward through train in redispatched operation, produces net difference of 45 cars.

(7) Douglas-Bisbee District (Turnaround trains only): Decrease account 33 west empties from Douglas and 30 west empties from Calumet which were moved on turnaround trains in actual operation, and by through trains in redispatched operation, and 8 loads, 4 empties which were moved by an eastward turnaround train in actual operation and by a through eastward train in redispatched operation, total 65 cars.

(8) Douglas-El Paso District: Account 57 west empties which moved via south line in actual operation and north line in redispatched operation.

(9) Average cars per train computed for total south line omitting 48 Douglas - Bisbee Jct. turnaround trains and cars handled by those trains. (Actual 3,171 cars; redispatched 3,106 cars.)

(10) Average cars per train computed for total north and south lines omitting 48 Douglas - Bisbee Jct. turnaround trains and cars handled by those trains. (Actual 3,171 cars, redispatched 3,106 cars.)

Superior Court, Pima Co., Arizona
State v. S.P.Co. No. 20087
Defts. Ex. No. 242 (Witness B. S. SINES)
(Sheet 1 of 2 sheets)

SOUTHERN PACIFIC COMPANY
(Pacific Lines)

REDISPATCH STUDY - OPERATING STATISTICS
YUMA, ARIZONA TO EL PASO, TEXAS
FOR PERIOD APRIL 4TH TO APRIL 30TH, 1940
ACTUAL OPERATION COMPARED WITH REDISPATCHED OPERATION,
WITH NO RESTRICTION AND USING AC POWER AND LONG SIDINGS

	NUMBER OF TRAINS (a)	TRAIN MILES (b)	OTHER LOCOMOTIVE MILES (c)	TOTAL LOCOMOTIVE MILES (d)	NUMBER OF CARS (e)	CARS PER TRAIN (f)
NORTH LINE						
I - Yuma - Gila						
Actual	397	46,371	2,784	49,155	25,123	66.6
Redispatch	396	36,408	2,776	39,184	24,804	65.8
Decrease for period	81	9,963	8	9,971	(1) 319	17.2
II - Gila - Tucson						
Actual	388	48,766	7,991	56,757	25,643	67.1
Redispatch	395	37,630	6,700	44,330	25,527	66.6
Decrease for period	87	11,136	1,291	12,427	(2) 116	19.4
III - Tucson - Lordsburg						
Actual	413	67,318	31,384	98,702	26,376	63.9
Redispatch	311	50,645	17,938	68,597	26,360	84.8
Decrease for period	102	16,673	13,452	30,125	(3) 16	20.9
IV - Lordsburg-El Paso (Through trains only)						
Actual	378	56,134	231	56,365	26,310	69.6
Redispatch	310	46,037	823	46,860	26,313	84.9
Decrease for period	68	10,097	592	9,505	(4)(1) 3	15.3
V - El Paso-Strauss (Turnaround trains only)						
Actual	-	-	-	-	-	-
Redispatch	84	420	-	420	1,057	(5) 88.1
Decrease for period	(1) 84	(1) 420	-	(1) 420	(1) 1,057	(5) 88.1
VI - TOTAL NORTH LINE						
Actual	1,550	218,589	42,390	260,979	103,452	66.7
Redispatch	1,236	171,140	28,231	199,371	104,061	(6) 85.0
Decrease for period	314	47,449	14,159	61,608	(1) 609	(6) 18.3
SOUTH LINE						
VII - Tucson-Douglas (Through trains only)						
Actual	71	8,803	810	9,613	3,577	50.4
Redispatch	71	8,803	810	9,613	3,577	50.4
Decrease for period	-	-	-	-	-	-
VIII - Douglas-Bisbee Jct. (Turnaround trains only)						
Actual	48	1,050	-	1,050	3,171	66.1
Redispatch	48	1,050	-	1,050	3,171	66.1
Decrease for period	-	-	-	-	-	-
IX - Douglas - El Paso						
Actual	57	12,428	216	12,644	2,734	48.0
Redispatch	57	12,428	216	12,644	2,734	48.0
Decrease for period	-	-	-	-	-	-
X - TOTAL SOUTH LINE						
Actual	176	22,279	1,026	23,307	9,482	(7) 49.3
Redispatch	176	22,279	1,026	23,307	9,482	(7) 49.3
Decrease for period	-	-	-	-	-	-
XI - TOTAL NORTH AND SOUTH LINES						

(Witness _____)

(Sheet 1 of 2 sheets)

SOUTHERN PACIFIC COMPANY
(Pacific Lines)

REDISPATCH STUDY - OPERATING STATISTICS
YUMA, ARIZONA TO EL PASO, TEXAS
FOR PERIOD APRIL 4TH TO APRIL 30TH, 1940
ACTUAL OPERATION COMPARED WITH REDISPATCHED OPERATION,
WITH NO RESTRICTION AND USING AC POWER AND LONG SIDINGS

	NUMBER OF TRAINS (a)	TRAIN MILES (b)	OTHER LOCOMOTIVE MILES (c)	TOTAL LOCOMOTIVE MILES (d)	NUMBER OF CARS (e)	CARS PER TRAIN (f)
NORTH LINE						
I - Yuma - Gila						
Actual	377	46,371	2,784	49,155	25,123	66.6
Redispatch	296	36,408	2,776	39,184	24,804	83.8
Decrease for period	81	9,963	8	9,971	(I) 319	17.2
II - Gila - Tucson						
Actual	388	48,766	7,991	56,757	25,643	67.1
Redispatch	296	37,630	6,700	44,330	25,527	86.5
Decrease for period	87	11,136	1,291	12,427	(I) 116	19.4
III - Tucson - Lordsburg						
Actual	413	67,318	31,386	98,702	26,376	63.9
Redispatch	311	50,645	17,938	68,577	26,360	84.8
Decrease for period	102	16,673	13,452	30,125	(I) 16	20.9
IV - Lordsburg-El Paso (Through trains only)						
Actual	378	56,134	231	56,365	26,310	69.6
Redispatch	310	46,037	825	46,860	26,313	84.9
Decrease for period	68	10,097	592	9,505	(4)(I) 3	15.3
V - El Paso-Strauss (Turnaround trains only)						
Actual	-	-	-	-	-	-
Redispatch	34	420	-	420	1,057	(5) 88.1
Decrease for period	(I) 34	(I) 420	-	(I) 420	(I) 1,057	(5) 88.1
VI - TOTAL NORTH LINE						
Actual	1,550	218,589	42,390	260,979	105,452	66.7
Redispatch	1,236	171,140	28,231	199,371	104,061	(5) 80.0
Decrease for period	314	47,449	14,159	61,608	(I) 609	(6) 13.3
SOUTH LINE						
VII - Tucson-Douglas (Through trains only)						
Actual	71	8,803	810	9,613	3,577	50.4
Redispatch	71	8,803	810	9,613	3,577	50.4
Decrease for period	-	-	-	-	-	-
VIII - Douglas-Rincon Jct. (Turnaround trains only)						
Actual	48	1,050	-	1,050	3,171	66.1
Redispatch	48	1,050	-	1,050	3,171	66.1
Decrease for period	-	-	-	-	-	-
IX - Douglas - El Paso						
Actual	57	12,426	218	12,644	2,734	48.0
Redispatch	57	12,426	218	12,644	2,734	48.0
Decrease for period	-	-	-	-	-	-
X - TOTAL SOUTH LINE						
Actual	176	22,279	1,028	23,307	9,482	(7) 49.3
Redispatch	176	22,279	1,028	23,307	9,482	(7) 49.3
Decrease for period	-	-	-	-	-	-
XI - TOTAL NORTH AND SOUTH LINES						
Actual	1,726	240,868	43,418	284,286	114,934	(8) 65.4
Redispatch	1,412	193,419	29,259	222,678	113,543	(8) 81.6
Decrease for period	314	47,449	14,159	61,608	(I) 609	(8) 16.2

I - Indicates Increase

(Sheet 2 of 2 sheets)

(1) Yuma - Gila District: Decrease of 156 engine water cars east, and 167 west; increase of four deadhead cabooses east. Total decrease of 319 cars on the redispatched trains.

(2) Gila - Tucson District: Decrease of 112 engine water cars and 4 deadhead cabooses.

(3) Tucson-Lordsburg District: Decrease of 14 deadhead cabooses east and 2 west. Total decrease of 16 cars on the redispatched trains.

(4) Lordsburg-El Paso District: Increase of 2 deadhead cabooses east, and 1 west. Total increase of 3 cars on the redispatched trains.

(5) El Paso - Strauss: Average cars per train (redispatch) computed for Strauss turnarounds by omitting 12 trains in the eastward direction as those trains handled none of the 1,057 cars, (all of these cars moved westward).

(6) Average cars per train (redispatch) computed omitting 24 El Paso - Strauss turnaround trains and 1,057 cars handled by those trains.

(7) Average cars per train computed for total south line omitting 48 Douglas - Bisbee Jct. turnaround trains and 3,171 cars handled by those trains.

(8) Average cars per train for total north and south lines omitting Strauss, and Douglas - Bisbee Jct., turnaround trains and cars handled by those trains

ACTUAL	No Strauss turnarounds	
	48 Douglas-Bisbee Jct. turnarounds with	3,171 cars
Total	48 trains omitted	3,171 cars omitted
REDISPATCH	24 Strauss turnarounds with	1,057 cars
	48 Douglas-Bisbee Jct. turnarounds with	3,171 cars
Total	72 trains omitted	4,228 cars omitted

the total, were produced in New Mexico and Texas. The 1940 studies show that about 21.4 per cent of the additional freight-train miles which the law would have required, contrasting full compliance with unrestricted operation, would have been produced extra-territorially in New Mexico and Texas.

The figures of additional train miles, both within Arizona and extra-territorially, set forth in Finding X(c), are based upon the redispatching study; however, they find confirmation in another independent computation which appears in the record. We refer to Exhibit 181 (R. 3073), which shows the traffic handled on the Tucson Division, measured in freight-car miles, the train miles required, and the average cars per train thus obtained, for the years 1925 to 1939, inclusive. The exhibit also shows the average train lengths which prevailed on the Salt Lake Division during the same years, and the number of train miles which would have been produced on the Tucson Division, if the average train length had been equal to that obtained on the Salt Lake Division. The differences between the train miles computed as last described, and those which were actually produced, represent the excess train miles incident to the compelled short-train operation on the Tucson Division. For 1938, the "excess" train miles thus derived amounted to 564,717. When it is considered that this figure relates only to operations between Yuma and Lordsburg, not including any operations on the Douglas main line, it serves to confirm very closely the showing on Exhibit 226. That exhibit shows a total train-mile saving for the main-line districts west of Lordsburg, not including the Phoenix line, of 92,675 train

miles for the two months of June and August; which figure, duly expanded to the annual basis as heretofore explained, produces a saving of 515,757 train miles for the districts mentioned, capable of accomplishment by unrestricted long-train operation. The variation between this figure and that obtained from the redispatching study is less than 9 per cent, which is readily accounted for when we remember that the calculation on Exhibit 181 takes into account all operations on the Tucson Division, including the alternate or auxiliary main line, and the branch lines; whereas the figure taken from the redispatching study relates only to operations on the principal main freight line between Yuma and Lordsburg via Gila and Tucson.

This finding likewise rests upon testimony not controverted in the least by appellee. It is directly material to the important issues presented by subparagraphs (f) and (g) of paragraph 3 of Part III of the answer (R. 13-15); and it also leads up to the succeeding finding, relating to the additional expense imposed upon appellant in the affected territory, by reason of its enforced compliance with the law.

(2) Passenger-train operations (R. 3965-3966):

This finding is a companion to Finding X(c)(1), setting forth a summary of the showing of record as to the effects of the law in restricting the lengths of passenger trains and compelling the operation of additional trains. The total of the compelled additional passenger-train service in 1938 amounted to 14,218 train miles, 3,900 of which were

extra-territorial, and 18,860 locomotive miles, 5,042 of which were extra-territorial.

There is no question of the practicability of long passenger-train operation in Arizona. The experience of March and April, 1940, is of itself a sufficient demonstration; but if it were not, the fact that appellant regularly and continually operates long passenger trains across Nevada and Utah, under conditions which are certainly no more favorable than in Arizona, amply attests the practicability of long passenger-train operation in Arizona.

Sines, R. 1365-1367, 1804-1912, 1815-1817, 1860-1863.
Exhibits 187 (R. 3079-3080), 188 (R. 3081), 230-232 (R. 3228-3230), 246 (R. 3255).

This finding responds to the essential allegations contained in paragraph 4 of Part III of the answer, particularly subparagraph (c), (R. 18) and is supported by undisputed testimony.

(d) INCREASED ANNUAL EXPENSE OF OPERATION, ETC., IMPOSED BY THE LAW (R. 3966-3969).

The question of the added expense imposed by the law is of much importance.* It was the subject of lengthy testimony, including numerous detailed exhibits. The finding, although it presents with some completeness the items which go to make up the total of the additional expense which the law would compel, really condenses the testimony within a comparatively brief compass.

*As pointed out at various places in Volume I of this brief, the State Supreme Court has conceded, by inference at least (its opinion, R. 4062-4063), that appellant's enforced compliance with the law compels it "to expend great sums of money."

The first paragraph of the finding (R. 3966) undertakes to state its entire substance: viz., that the additional expense imposed upon appellant amounts to not less than $394,900 per year, all of which expense is and will continue to be recurring and irreparable, and could be saved and avoided if the restrictions of the law were removed. There can be no real question that the added expense, whatever its amount, is continuous and irreparable. The precise amount shown in our exhibits and stated in the findings may possibly be disputed; but that it is substantial, recurring, continuous, and irrecoverable, even though the law should be set aside, must be conceded. The very fact that this prosecution has been so vigorously sponsored by the interested railroad labor organizations shows that the amount of the wage item alone must be very substantial.

Most of the items which go to make up the total are not seriously questioned. These include in particular: (1) the wages of additional enginemen and trainmen, now incurred because of the additional freight trains compelled by the law, but which would not be incurred if such trains were not compelled to be operated, amounting to $285,653.42; (2) the additional passenger operating expenses, including wages, enginehouse expenses, locomotive supplies and locomotive repairs, incident to the additional passenger train service compelled by the law, amounting to $10,884.00 per year; (3) interest, maintenance, and depreciation charges upon the additional investment in 21 cabooses which would not be required if the law were disregarded, and are now required solely because of the

additional freight-train service compelled by the law, amounting to $8,747.00 per year.

Exhibits 225 (R. 3214), 229 (R. 3227), 231 (R. 3229).

The total of these undisputed items is $305,284 per year. They are somewhat offset, however, by the annual charges for interest, maintenance, and depreciation upon the additional facilities which appellant would construct or acquire in order to conduct long freight-train operations readily, efficiently and economically in the affected territory; that is to say, the extensions of yard tracks and sidings, the increased investment in larger locomotives, and the expanded roundhouse, water service, and shop facilities required for the proper maintenance and servicing of those locomotives. The total of these offsetting charges amounts to $87,752 per year.

Exhibit 225 (R. 3214).

In addition to the above mentioned items of savings, as to which there is apparently no dispute at all, there are two additional items of potential savings which appellee has sought to question: locomotive fuel; and locomotive repairs for locomotives in freight-train service. The saving in locomotive fuel during the months of June and August, 1938, for locomotives operating between Lordsburg and Yuma amounts to $17,352 (Exhibit 250, R. 3262), and for locomotives between Lordsburg and El Paso $2,660 (Exhibit 251, R. 3263), a total of $20,012; which when expanded to the annual basis, gives a total potential saving in locomotive fuel, on the basis of the 1938 traffic volume, amounting to $111,860. The derivation of the

figures showing the fuel saving for the year 1938, and also the corresponding saving achieved or capable of achievement by long-train operation during the period April 4th to 30th, 1940, are fully set forth on Exhibits 249, 250, and 251 (R. 3258-3263), and in the accompanying testimony (*Sines*, R. 1875-1891); and to save repetition we invite attention to the testimony. The potential fuel saving in the affected territory is based upon the showing of actual fuel savings achieved by long-train operations on other portions of the system; but the fuel saving shown for the affected territory is understated, being considerably less than actually achieved by appellant's long-train operations elsewhere.

The showing of potential savings in locomotive repairs is likewise based upon actual experience in the affected territory, and upon the system as a whole, for the types of locomotives presently in use and those contemplated for use in the long-train operation. Locomotive repairs are of two general classes: so-called "shop" repairs, as to which an accurate cost record is compiled, by individual locomotives and by types, for years and groups of years; and "running" repairs, where no such individual or type record is compiled, only the total amounts expended, by divisions and for the system, being recorded. Appellant thus has a record for each year of the cost of all locomotive repairs; and a record, by types and individual locomotives, of all shop repairs; and by experience can determine, on the basis of the relationship borne by all shop repairs to all repairs, the total cost of all repairs to a particular class or type of locomotive. Locomotive repair costs are calculated on the cents-per-mile basis, for each

mile operated by each class of locomotive. Since the locomotive miles actually run by the locomotives in freight service in the affected territory during June and August, 1938, were of course available, and the locomotive miles made by the various types used on the redispatched trains were also capable of being computed and were in fact compiled, there was no difficulty in obtaining, on the one hand, the computed aggregate cost of locomotive "shop" repairs of the locomotives actually run, or the corresponding computed aggregate cost of "shop" repairs of the locomotives handling the redispatched trains.

Sines, R. 1897-1913.

Exhibits 254 to 257 (R. 3260-3269).

The difference, amounting to $36,024 (Exhibit 317, R. 3435), represents the actual saving in shop repairs, which would have been achieved if long freight-train operation had been undertaken throughout the year 1938 in the affected territory. This figure, however, represents only 55.5 per cent of the total cost of all repairs; for the system experience over the last ten years shows that on the average running repairs are 44.5 per cent of the total locomotive repair bill (Exhibit 257, R. 3269). Expanding the figure of savings in shop repairs to a proper figure representing the savings in both shop and running repairs, the total is $65,500.00.

Adding together all of the potential savings, including the items of wages, fuel, locomotive repairs, caboose interest and maintenance, and savings in passenger train operations, and offsetting them by the added annual charges previously referred to, the net potential saving,

which is also the measure of the added annual expense imposed by the law, and which could be avoided if it were not for the law, amounts to not less than $394,900.

Extra-Territorial Portion of the Added Expense Imposed by the Law (R. 3968).

Just as a substantial proportion of the added train service compelled by the law is performed outside of Arizona, so a substantial proportion of the added cost incident to that train service is incurred extra-territorially. The concluding portion of Finding X(d) sets forth that that total extra-territorial expense, based upon the 1938 redispatching study, amounts to $94,600. The computation by which this figure is derived is comparatively simple. It consists merely of obtaining, in the case of freight service, the average cost per train mile for the particular items as to which a saving is established by the testimony, and applying that average saving to the extra-territorial train miles compelled by the law. A similar method is followed in computing the additional expense involved in extra-territorial passenger train operations.

Sines, R. 1894-1897.

Exhibits 232 (R. 3230), 253 (R. 3265), 299 (R. 3429).

Separate computations appear in the record, based upon the 1940 redispatching studies, showing the additional expense imposed by the law, both in the aggregate, and as related to extra-territorial operations. (Exhibits 256, R. 3268, 258, R. 3270, and 259, R. 3271). Without going into the detail of these exhibits, it may be said that, as stated in the concluding paragraph of the finding, they

confirm very closely the showing of additional expense based on the 1938 study.

XI.

SLACK AND SLACK-ACTION IN TRAINS: NATURE, CAUSE AND EFFECTS (R. 3969-3974).

Appellee's counsel, in the course of the examination of certain of its witnesses, laid considerable stress upon slack and slack-action in moving trains, as an alleged source of potential hazard and injury; taking the position that the length of a train, and that factor alone, determines the amount and severity of the slack-action, and that the challenged law has, as its purpose and result, the elimination of that supposed source of hazard by means of the fixed limits imposed upon train lengths. On the other hand, appellant sharply challenges this position and contention of appellee, and presented testimony, summarized in Finding XII, which shows the nature and extent of that alleged hazard, as reflected in the casualty and accident statistics.

The trial court concluded that it was essential that the findings should present a complete and accurate description of slack, and the slack-action associated therewith, as to their nature, extent and controlling factors; and accordingly it adopted Finding XI, wherein is summarized the testimony of witnesses for both parties on this phase. We see no need to argue this finding at length; the facts, as presented by the finding, are themselves the best argument. We shall, however, emphasize certain of the more

significant points developed by the record, and summarized in the finding.

(a) DESCRIPTION OF DRAFT RIGGING (R. 3969-3970).

This portion of the finding is based upon undisputed testimony, and is included primarily for the purpose of permitting a proper understanding of the following subdivisions. None of the facts set forth in this paragraph is questioned.

Exhibit 210 (R. 3194).

(b) ACTION OF DRAFT GEARS (R. 3970-3971).

This portion of the finding enumerates and describes the two types of gears, the tandem-spring type, and the friction type, now in use on freight cars, and explains briefly the means whereby these draft gears absorb and reduce the pushing and pulling shocks imparted to cars in the course of operation. This portion is likewise based upon undisputed testimony: primarily of Witness Bohnstengel, whose qualifications upon the subject matter are outstanding.

Bohnstengel, R. 1679-1698, 1705-1706.
Exhibit 210 (R. 3194).

The portion of the finding which states the amount of force which a friction draft gear can absorb, before the complete amount of the movement of which it is capable is produced (i.e., "complete closure"), is particularly significant because of the apparent contention of at least one of appellee's witnesses (*Purnil*, R. 2372) that there is a foot (12 inches) or more of slack in every car of a freight

train, when the train is running. The fact is that the total movement (or so-called "free slack", plus "controlled resistance") is much less than 12 inches in normal operation (apparently about 7½ inches); but whatever the amount it is not fully extended in a moving train by the pulling force of the locomotive.

(c) SLACK AND SLACK-ACTION DEFINED (R. 3971).

This paragraph of the finding consists simply of definitions, as to which there has been no dispute. It was included, apparently, for the purpose of avoiding the confusion, revealed at times in the testimony of appellee's witnesses, between "slack" (i.e., relative motion of the cars, on the one hand) and "slack-action", which, as the finding states, is the accumulated effect of that motion, as created or brought into play in train operation.

(d) FACTORS AFFECTING SLACK-ACTION: AMOUNT DEVELOPED IN OPERATION (R. 3971-3973).

This paragraph of the finding reproduces in summary form, statements made by appellant's witnesses, and confirmed by several of appellee's witnesses, principally in admissions made in their answers to cross-examination. It demonstrates that appellee's counsel err completely, when they suggest or contend that the extent and severity of slack-action, as experienced in train operation, depend entirely or even principally upon the number of cars in the train.

The fact is that a wide variety of circumstances affect or may affect slack-action; and the combination of these circumstances determines whether, when the opportunity for slack-action occurs, the action will be severe, or mild,

or possibly not developed at all. The principal factors which thus affect and determine slack-action are: the speed of the train at the time; consist of the train (whether loads or empties, and if partly loads or empties, the proportion of each); weights of the loads in the train; distribution and relative position of loaded and empty cars; grade upon which the train is running; whether the train is starting, accelerating, or slowing down; and the action taken by the engineer, in the use of the air brakes and the locomotive power.

The train length is of minor importance, compared to any of these other factors; if other conditions exist favorable to the development of severe slack-action, the result may be much more serious at the rear of a train substantially shorter than the law permits, than would be produced, under other conditions adverse to the development of shock, at the rear of a much longer train. The law, since it is only a "make-work" measure masquerading as a safety statute, cannot and does not attempt to take any of these other factors into account; and therein resides one of its most arbitrary and indefensible characteristics.

The contention or suggestion of opposing witnesses, that emergency stops of long freight trains almost always cause severe slack action at the rear end of the trains, with resulting injuries, or possibility thereof, to persons riding in the caboose, is likewise shown to be untenable by the testimony summarized in this part of the finding. The fact is that emergency stops of long freight trains, both desired and undesired, can and do occur without severe shock; on the other hand, as shown by the testimony sum-

marized in Finding XII and our discussion of that finding, emergency stops of short trains, when they occur, sometimes cause severe shocks with results which, from the casualty standpoint, are at least as unfavorable as those experienced in long-train accidents.

Bohnstengel, R. 1692-1697, 1701-1702; *Durnil*, R. 2390-2392; *Kennedy*, R. 2415-2416, 2429-2430, 2433-2437; *Cooper*, R. 2443-2446; *Stevenson*, R. 2489-2491, 2493, 2496, 2498-2501; *Ash*, R. 2576-2577, 2579-2580, 2596-2603; *Fail*, R. 2611-2613; *Shaw*, R. 2649-2650, 2652-2653; *Fifield*, R. 2786-2799, 2800-2804, 2805-2806; *Menzies*, R. 2815-2823.

Exhibits 210 (R. 3195), 266 (R. 3304), 270 (R. 3310-3335), 274 (R. 3351-3363), 275 (R. 3364-3370), 280 (R. 3375), 295 (R. 3424), 386 (R. 3533-3547), 387 (R. 3548-3557).

The contention that the challenged law results in eliminating or even reducing slack-action casualties is wholly unfounded. The ultimate test of that contention is found in the results of the regulation of train lengths in Arizona, as contrasted with the results of operation without that limitation in Nevada and other states. That analysis will be found in those parts of our proposed Finding XII comparing the Nevada, Arizona, and other slack-action casualties over a period of years. The experience with the Arizona law demonstrates that the mere limitation of length is quite ineffective for the purpose asserted by appellee. That ineffectiveness is plainly due largely to the fact that the law operates arbitrarily upon train length alone, without regard to the other factors enumerated in

subfinding (d), all of which may and do contribute to and determine the extent and severity of slack-action.

(e) SLACK-ACTION IN PASSENGER-TRAIN OPERATION (R. 3974)

The finding concludes with a brief paragraph relating to slack-action in passenger-train operation.

The evidence wholly fails to indicate that there is any hazard whatever, from a practical standpoint, because of slack and slack-action in passenger-train operation, no matter what the length of the train. It is particularly noteworthy that the showing upon this subject is almost entirely negative in character. Appellee was unable to point to any slack or slack-action casualties in passenger-train operation and in fact indicated, by the testimony of its only witness who discussed the subject, that such casualties rarely if ever occurred; and appellant's witnesses confirmed this showing. In the exhibits which describe and list the passenger-train casualties occurring in Nevada, Arizona and New Mexico, there are no casualties described as having occurred by reason of slack-action in a passenger train of more than 14 cars, occurring in circumstances where the operation of that train would not have taken place if the Train-Limit Law had been observed. There is no showing of any Nevada or New Mexico casualty occurring on a long train where slack-action was involved. There is a showing (Exhibit 294, R. 3423) of a claimed "sudden-jerk" injury to a woman passenger on a consolidated train in Arizona, consisting of 26 cars; but the train, though exceeding the 14-car limit, was within the provisions of the Arizona law, be-

cause of the exception permitting trains to be consolidated in the event of engine failure between terminals.

Exhibits 271 (R. 3336-3348), 292 (R. 3412-3421), 294 (R. 3423), 362 (R. 3501-3506).

The fact is that in passenger-train operation, and whether the train be considerably less than 14 cars or considerably over that figure, the action of the brakes, when an emergency application takes place, although not simultaneous through the train is very rapid; and there is practically no opportunity for slack-action to develop. A sudden stop of a passenger train is therefore, to all intents and purposes, much like the sudden stop of an automobile or a street car; while the stop may be severe, the surge and shock is the same in the head cars of the train as in the rear cars. The shock in the rear cars is due, as in the forward cars, to the sudden application of the braking power throughout the train, rather than to any sudden stopping of the rear cars because of running into the forward cars already halted by the brake application.

Cheek, R. 2467-2471, 3477-2480, 2483-2486; *Hardwicke*, R. 2731; *Fifield*, R. 2799-2800, 2806.

The total lack of significance of the 14-car limitation, insofar as slack-action is created or the engineer's ability to control the train affected thereby, is pointedly illustrated by the testimony of appellee's witness Cheek. Although Engineer Cheek handled two long passenger trains between Tucson and Yuma during the month of April, 1940 (Exhibits 393 and 394, R. 3569-3570), he was

apparently unaware of that fact until it was demonstrated to him by inspection of the permanent records. Compare also the testimony of witness Fifield, appellant's Road Foreman of Engines, to the effect that an engineer handling a passenger train is frequently uninformed whether his train exceeds 14 cars or not, and neither seeks nor requires that information, insofar as good train handling is concerned (R. 2806).

General recognition of this fact, by appellee's counsel and witnesses, was apparently responsible for their failure to contend seriously that slack and slack-action constitute a factor of importance, or indeed of any significance at all, from the standpoint of hazard to persons and property, growing out of or connected with passenger train operation.

XII.

SAFETY OF OPERATION AS AFFECTED BY TRAIN LENGTHS: ACCIDENT AND CASUALTY STATISTICS (R. 3974-4022).

While the safety findings are lengthy, they are not argumentative except by the inexorable logic of established facts.

To avoid needless repetition in this discussion we again suggest that the finding be examined before reading the comment thereon in the subsections under this chapter heading. What we shall have to say as to Finding XII is largely a series of footnotes to its respective subdivisions.

Statistical trends and comparisons.

When an attempt is made to express in statistical form the frequency of accidents or casualties on modern railroads or even on one large railroad system, the units of service or performance to which the comparatively small number of such occurrences must be related are almost astronomical in their immensity.

Thus, the standard bases of measurement used by the Interstate Commerce Commission and carried in the statistical tables with which this chapter will largely deal are translated into terms of everyday experience and observation:

A *million freight-train miles* would provide 2551 trips across Arizona (392 miles) on appellant's main line, or 2257 trips across Nevada on appellant's line from Calvada to the Utah line (443 miles). A trainman on a regular freight run seldom makes more than 3500 miles in a month.

A *hundred million freight-car miles* equals 3644 seventy-car freight trains traveling across Arizona, or 3225 across Nevada.

A *million man hours* equals 125,000 eight-hour work days.

A *million passenger miles* equals 155 eight-day round trips, San Francisco via Chicago to New York and return (6446 miles).

It is only by comparison of such frequencies over periods of time sufficient properly to discount fluctuations and to present trends and averages, rather than casual hap-

penings widely differing in resulting damage or injury, that proper conclusions can be reached as to the relative merits of different methods of operation.

That is particularly true of a selected class of accidents or casualties, such as those charged to slack action, which arise from a combination and concurrence of a number of factors, lack regularity of occurrence and are so infrequent that—particularly referring to Arizona, Nevada, and New Mexico—one or two, even of minor consequence, will distort frequency rates, overweight averages, and impair comparisons, unless the period considered is of sufficient length to be fully representative.

In statistical presentations, trends are particularly significant when they appear in a fully representative period and consistently rise or decline, even though there may be fluctuations in individual years during the period.

When as here methods of operation have radically changed over a series of years, a comparison of a representative period during which the old method prevailed with the latest similarly representative period of the changed operation is of great value. For it should be remembered that the reasonableness of the challenged law is to be measured by present-day conditions and not by those obtaining in 1912, more than thirty years ago.

Use of the year 1923 as the starting point in practically all of the statistical tables hereinafter referred to is justified because it was in 1923 that railroads in general, including appellant, adopted the standard long-train method of operation and initiated the improvements neces-

sary to carry that method into effect. (*Parmelee*, R. 189-190).

In *St. Louis and O'Fallon Ry. Co. v. United States* (1929), 279 U.S. 461, 73 L.ed. 798, Mr. Justice Brandeis graphically described (p. 523) the changes that were made to produce what he termed the "efficient post-war railroad plant"; those changes, as shown by the evidence in the case at bar, were determined upon in 1923, and at once begun and continued.

As practically all of the statistical tables of accidents and casualties introduced by appellant were based on the Accident Bulletins of the Interstate Commerce Commission, or reports to that commission from its Bureau of Safety in special cases, or on Form T reports made to the commission under the Accident Reports Act, it is in point here to quote the language of this Court in: *Retirement Board v. Alton Railroad Co. et al.*, supra (295 U.S. 330, at p. 364):

> "*Incontrovertible statistics* obtained from the records of the Interstate Commerce Commission *show a steady increase in safety of operation* during this period of alleged increasing superannuation."

The tables appended as a note to that statement were taken from the Accident Bulletins of the Interstate Commerce Commission, cover the period 1923-1932, and were the same as those for the years 1923-1932 contained in the exhibits offered through Mr. Sullivan, who carried the same statistical comparisons down to the latest available dates.

Again, the Court said (p. 366):

> "The trial court found, and its finding is not assigned as error: 'Railroads were, when the Act was enacted, and are now, operated efficiently and safely and more *efficiently* and *much more safely* than at any time in history.'" (Emphasis ours).

We have previously referred to the note on that page, in which the Court called attention to the progressive increase in speed of freight trains and in the average gross ton miles and net ton miles per freight train, using many of the same figures, from the same sources, as used by Dr. Parmelee in the instant case.

The trends in operating averages commented on by the Court in that opinion which was written in 1935, have continued to the last available statistical date, as we showed in detail on a series of exhibits we now briefly review.

The foundation and background for the national statistics relating to train and train-service accidents are summarized in our discussion of preceding findings and in the findings themselves. First there were the exhibits and testimony from Dr. Parmelee and Mr. Otterback, who dealt with the railroads as a national transportation plant composed of a large number of railroad systems, physically connected, freely exchanging cars and their contents under uniform interchange rules and joint schedules, whose operating rules are in general standardized, and who through mutual understanding have collectively improved the national transportation plant since 1923 by an expenditure of more than seven billion dollars.

Testimony and exhibits were produced by appellant from officers of seventeen railroads, including appellant, which in 1939 performed about sixty per cent of the freight-train car miles and revenue-passenger miles of Class I American railroads.

At this point we summarize the exhibits covering the Class I railroads as a group, as well as the individual railroads.

FREIGHT TRAIN STATISTICS
PERCENTAGE INCREASES 1939 OVER 1922

Exhibit Number	Name of Railroad	Cars per Train	Net Tons per Train	Tractive Power per Locomotive	Speed M.P.H.	Gross Ton Miles per Freight Train Hour
22	Class I Rys. of U. S.	27.9	20.3	34.6	50.5	102.7
12	New York Central	12.7	16.0	24.4	52.3	83.0
25	Missouri Pacific	32.4	15.4	41.4	53.9	113.9
29	Illinois Central	8.0	—	36.6	44.2	59.1
47	Great Northern	36.6	30.2	45.2	44.7	115.0
49	Northern Pacific	26.3	22.8	36.2	25.6	72.3
52	Rock Island	23.1	9.9	43.3	55.5	103.5
56	Erie	35.3	17.3	33.6	63.5	128.4
60	St. Louis S. W.	22.2	1.5	29.5	84.1	128.9
64	Chicago & N. W.	42.2	41.2	24.4	36.4	111.2
68	Pennsylvania	55.6	39.1	34.9	50.0	133.1
79	Union Pacific	32.5	15.3	39.1	60.0	122.0
87	Boston and Maine	63.3	65.1	34.9	35.3	144.9
95	Chgo., Mil., St. P. & Pac.	21.2	17.6	27.1	45.1	92.9
103	Chgo., Burl. & Quincy	11.6	—	39.9	47.9	74.3
121	Chesapeake & Ohio	53.2	59.3	38.2	68.2	170.1
131	A. T. and S. Fe	10.6*	3.1*	29.9	51.9*	83.3*
162	So. Pac. Co. Pac. Lines	25.8*	13.3*	40.2	53.2*	105.6*

*The Santa Fe and Southern Pacific System average percentages of improvement were of course subject to the depressing influence of the Arizona Train-Limit Law.

The operations of those railroads were described in considerable detail. The development of their motive power

and equipment, including the refrigerator and Pullman cars that have a widespread and interchangeable use, was also testified to. In general that development followed along the same lines as the motive power, equipment, and refrigerator cars of the appellant shown pictorially and by description on Exhibits 2 (R. 2852), 3 (R. 2853), 4 (R. 2854), 5 (R. 2855), 6 (R. 2856), 107 (R. 2960), and 135 (R. 3002).

Copies of the exhibits just mentioned by number are, for convenient reference, bound inside the last cover page of this brief.

From annual reports of the carriers to the Interstate Commerce Commission exhibits were introduced, showing the character and volume of commodities handled in freight service (Exhibits—S. P. Co., Arizona, 167, R. 3041, 217, R. 3204; S. P. Co., Nevada, 169, R. 3043, 219, R. 3208-3209; S. P. Co., New Mexico, 168, R. 3042, 218, R. 3246; Illinois Central, 105, 106, R. 2958-2959; Erie, 57, R. 2908; Chicago and Northwestern, 65, R. 2916; Pennsylvania, 69, R. 2920; Northern Pacific, 70, R. 2921; Rock Island, 71, R. 2922; Great Northern, 72, R. 2923; Union Pacific, 80, R. 2932; Boston & Maine, 88, R. 2941; Chicago, Milwaukee, St. Paul & Pacific, 96, R. 2949; Chicago, Burlington & Quincy, 104, R. 2957; Santa Fe, 132, 133, 134, R. 2994-3001).

These exhibits further support the comparability of the operating statistics.

Witness Browning went fully into the development of the interchange rules (Exhibits 203, R. 1559-1562, 204, R. 3153-3189), and Chief Engineer Parke of the Pullman

Company into that of Pullman equipment (Exhibits 107, 108, 109, R. 2960-2963).

As far as practicable, and without protracting the trial to inordinate length, the increase in operating efficiency and freight-train lengths and speeds was shown by the series of exhibits which we have summarized in tabular form above.

Feeling that the mere statistical average of average freight-train lengths obtained by dividing car miles by train miles was not completely representative of long-train operation as a standard national practice, appellant submitted a series of exhibits showing typical freight and passenger-train operations on the sixteen railroad systems referred to, which is summarized in Finding VIII(b).

It is obvious that an individual safety showing could not have been made for each of those sixteen railroads, such as made for appellant, without taking an enormous amount of time in preparation and trial. It is equally obvious that such a showing would merely have confirmed the national showing of trends of train and train-service accidents which we made in great detail.

However, a casualty showing was made as to the Santa Fe which is summarized in Finding XII(k), R. 4004-4006; and the Chesapeake and Ohio, an outstanding example of long freight-train operation, summarized in Finding XII(l), R. 4006-4007.

The foundational findings for the national comparisons are grouped under the following subdivisions of Finding VIII, and are, by subdivisions:

(a) Improvements in Road and Equipment (R. 3934).

(b) Increased Train Lengths (R. 3937).

(c) Improved Schedules and Performance (R. 3939).

(d) Increased Efficiency and Economy (R. 3940).

(e) Results of the Long-Train Program From the Standpoint of the Public, the Employes, and the Railroad Owners (R. 3943).

(1) Reduction in Average Transportation Charges Paid by the Public (R. 3943).

(2) Increases in Average Wages Paid to Employes (R. 3943).

(3) Effect on Returns to Owners of the Railroads (R. 3944).

(f) Similarity of Operating Conditions and Operating Rules on Other Railroads to Those Prevailing Upon Defendant's Lines in the Affected Territory (R. 3945).

No useful purpose can be served by a mere collection of casualties or accidents occurring on or to trains within or without the law's limitations. Such a list affords no criterion of hazard unless it is related to some proper basis of frequency measurement.

We can and did match every reported "long-train" casualty or train accident referred to by appellee with one or more "short-train" casualties or train accidents of the same character. But that alone would not materially assist the Court in concluding which is the safer method of operation.

Relation of the frequency of such occurrences to some unit of performance is necessary to informed judgment.

On this branch of the case the law under attack must be sustainable, if at all, under the state's police power. Neither by title nor by recital does it declare any reason for its enactment, or describe any situation to be remedied or prevented.

Appellee's counsel have contended, and will doubtless again contend, that it is a "safety regulation". No opinion evidence on that point is before the Court; the proof pro and con is wholly statistical as to occurrences, and descriptive as to conditions. The claim of "safety" has been largely if not entirely confined to the so-called slack-action accidents, but the evidence shows that since 1912 great improvements in road-bed, signals, motive power, and equipment, and the consequent increase in train lengths, have so reduced accidents from that cause that they have decreased to a point that is difficult to express statistically; and further, that as a practical matter the frequency of such accidents is generally the same on both classes of trains, on a train-mile basis, and substantially less on a car-mile basis, in moving the traffic by the long train method of operation. If "safety" means, as it should mean, safety from all causes and to all persons subject to the hazard of train operation, then the evidence shows—not "beyond a reasonable doubt", but beyond *any doubt*—that the long-train method of operation is by far the safest.

We again emphasize that the railroad plant of today, in Arizona, on the appellant's Pacific Lines, and in the

nation as a whole, is entirely different from that of 1912. Safety of operation is to be measured by the standards of the present. The railroad management has the duty to receive, transport, and deliver freight and passengers, when and as presented for transportation. We believe that it is not even "debatable" that that duty can be performed with the greatest safety to all persons and property so transported, by using as few train miles as the character and volume of traffic, and the physical characteristics of road, motive power and equipment wil permit.

Having made that showing, the appellant has proven its case under the due-process clause of the Fourteenth Amendment, and has fully measured up to the degree of proof required by even the most extreme opinions that have considered attacks on state police power statutes.

(a) ACCIDENT REPORTS TO INTERSTATE COMMERCE COMMISSION (R. 3974-3975).

This finding is necessary as a proper foundation for the finding that follows and is based on the exhibits shown in the annotation, which are excerpts from the Interstate Commerce Commission's rules governing reports of train and train-service accidents. Its correctness has never been challenged by appellee.

(b) BASES FOR COMPUTING ACCIDENT AND CASUALTY RATES (R. 3976).

This finding is the basis for the constant references in the successive findings to the various methods of measuring frequency of train and train-service accidents. Its correctness likewise has never been disputed by appellee.

Most of the exhibits pertaining to freight-train operation covered by the series of findings under Finding XII are on both the train-mile and car-mile basis. Some of them include as well one or both of the bases of man hours and locomotive miles, explanation for the bases used having been given in most cases when the exhibit was identified.

As to the *car-mile basis* Mr. Sullivan said (R. 1939) that it "is a recognized measurement of the occurrence of casualties to the movement of a given amount of traffic."

That basis was not always available, but when statistics afford its use it is peculiarly applicable to the instant issue. The railroad is a common carrier and holds itself out as ready, able and willing to carry property for hire. It must do so when and as that property is tendered to it for transportation. It is liable under bill-of-lading provisions for delay or damage to freight due to its negligence.

Freight traffic is measured in units of cars because practically all freight moves in carload lots; only a very small percentage of the total volume moves in less-than-carload lots, and even those are handled in cars.

The fairest and most accurate method of measuring casualty frequency as to different types of freight operation is to use the car-mile basis, because the purpose and obligation of the carrier is to move and deliver cars and not trains, and the duty and concern of the management is to handle the cars under the operating practices that will expose employes and the public to the least hazard

of casualty; a secondary but important consideration in the protection of equipment and lading.

In some of the exhibits casualties are related to *man hours* because neither train miles nor car miles were statistically available; e.g., in terminal yards, where neither of those classes of miles is accumulated (*Sullivan*, R. 1939-1940).

Locomotive miles also appear in some of the exhibits which include terminal operations, where train miles are not produced and therefore not statistically reported. But locomotive miles are also accumulated in train operation. A train with a single locomotive running 100 miles would be statistically reported to the Interstate Commerce Commission as producing 100 train miles and 100 locomotive miles; whereas if two locomotives were used for the trip 200 locomotive miles but only 100 train miles would be reported. The same applies to helper service.

But let us take the illustration of three trains instead of two being used to handle 210 cars on the road—the wasteful practice compelled by the Arizona law. Assuming the run to take eight hours with one engineer, one fireman, one conductor and three brakemen on each train, as would be required in Arizona, the movement of the 210 cars by short trains would produce 144 man hours of exposure to occupational hazard, while the long trains performing the same amount of transportation service would furnish a similar exposure of but 96 hours; this does not take into account the multiplication of hazard by the increased number of trains.

The same trains in single engine operation would produce 300 short-train locomotive miles and but 200 long-

train locomotive miles. In the latter case there would be one-third less hazard from the causes of train and train-service accidents inherent in the operation of a train drawn by but one locomotive, again disregarding the unnecessary trains that used the same trackage and yards.

The *train-mile* basis is not to be disregarded. Cars are moved in trains and the number of trains used to move a given number of cars has an important bearing on the safety of operation. It is a controlling factor in the hazard of transportation, to individuals as well as to motive power, cars and contents.

The train-mile basis is less satisfactory than the car-mile basis when comparisons are undertaken between long-train operation in one territory and restricted operation under a compulsory maximum limit in another; especially if the purpose of the comparison is, as in the present case, to develop whether the hazards incident to the discharge of the railroad's obligation to move the traffic are increased or reduced by the compulsory limitation. For such a purpose the car-mile basis is obviously more accurate, because the amount of traffic to be moved (which is the measure of the carrier's performance of its obligation) is measured in car miles, not train miles. Again, the artificial limitation compels the production of a far larger number of train miles than otherwise would be necessary for the movement of the traffic; and thus, while increasing the exposure and (as is shown by experience) the actual number of accidents and casualties incurred in proportion to the traffic moved, also arti-

ficially increases the base against which their frequency is measured, if the train-mile basis alone be used. As a concrete example, accidents and resulting casualties are, and have been in general, substantially more numerous in Arizona than in Nevada, although the traffic volume in the two states has been approximately equal (from 3 to 5 per cent greater in Nevada); but because of the artificial increase in the number of trains run, and the number of train miles made, in Arizona (solely because of the law's limitations) comparisons between the two states on the train-mile basis show somewhat less differences in the frequency rates than corresponding comparisons on the car-mile basis.

Of course, no such infirmity obtains in comparisons on the train-mile basis, when made between different years or groups of years, in the same states or on the same system, and where the differentiating factor of an artificial limit is absent. And in the national statistics where the enforced limitation on the Santa Fe and Southern Pacific in Arizona affects a relatively small percentage of the national totals, the train-mile basis affords instructive comparisons between different years and groups of years.

Thus if, as is compelled in Arizona, three freight trains must be run to handle the same number of cars that might be, and on other parts of the system are, handled in but two trains, eighteen employes instead of twelve are exposed to whatever hazards are inherent in the operation of a single train. And those hazards are further increased by the multiplication of hazards from collisions, grade-

crossing accidents, meeting and passing other trains, etc. This demonstrable increase in hazard accounts for the substantially more favorable casualty showing of long-train operation, even on the *train-mile basis*. There are inescapable and unpredictable *hazards* inherent but of irregular occurrence in the movement of any train; the movement of any means of conveyance, whether it be a horse, a bicycle, a motor vehicle, a street-car or a steam or electric train, has known dangers. Common observation tells us this, and actuarial tables based on experience and used in fixing premium rates for casualty insurance are merely calculations of hazard based on experience statistics such as we have produced.

The tables we analyze show beyond any doubt that the so-called slack-action casualty is so infrequent and subject to so many factors of production that limiting trains to the Arizona maxima has no perceptible limiting effect on that class of accidents. In fact, as we show statistically as well as by reason, the limit of 70 cars to a freight train tends to increase that class of accident. There is no hazard from slack action that can be statistically shown as to passenger trains of any length.

Whatever method of measurement be used, the "incontrovertible" statistics leave no room for debate as to the extreme arbitrariness and unreasonableness of a regulation that compels appellant to use additional and unnecessary man hours, locomotive miles and train miles to handle a volume of traffic that can be far more safely handled by the method it and other railroads use elsewhere.

(c) NATIONAL ACCIDENT AND CASUALTY STATISTICS (R. 3976-3980).

This sub-finding first states the source of the statistics above referred to, and is further divided into six classifications to which we shall now briefly refer.

The first paragraph of this sub-finding refers to the national accident and casualty exhibits in general terms, calling attention to Finding VIII(b) for a description of the increases of the lengths of freight trains on Class I railroads of the United States during the 17-year period, 1923-1939. The subdivision of that finding which deals with increased train lengths is on pages 3937-3938 of the record and is fully annotated to the testimony. It states the growth and prevalence of standard long freight-train operation in the United States. The significance of the national statistical tables covering train and train-service accidents cannot be appreciated, without considering that the improvement in accident and casualty rates therein shown is accompanied by and closely corresponds to the increases of average length of freight trains shown by the various tables referred to in the annotations to Finding VIII(b). It should also be borne in mind that the national figures on freight-train lengths are arrived at by dividing freight-car miles by freight-train miles, and that the averages are depressed because the only available statistics include all freight trains, through and local, main line and branch line. It is a fair conclusion from the testimony of the witnesses who represented 125,885 miles of the 232,026 road miles operated by Class I American Railroads in 1939, and produced 58 per cent of the freight-train car miles operated and 60.06 per cent of the revenue-

passenger miles (Exhibit 248, R. 3257), that the percentage decreases in the various classes of train and train-service accidents throughout the period covered by the study have accompanied a very much greater percentage increase, in the lengths of the freight trains that carry through traffic, than the national average of all freight trains would indicate.

It has been argued by appellee that the substantial national improvement in accident and casualty frequencies is due primarily to the improvements in road and equipment. To whatever extent that be true, it is an additional reason for striking 32-year-old fetters from the hands of interstate commerce. Unquestionably those improvements have had a large share in the lessening of railroad operating hazards, but they were made for the very purpose of permitting the *safe, economical* and *efficient* operation of long trains; and it is evident from the record that the improvements were in and of themselves merely one of the factors, and not the sole major factor, in producing the decrease of accident and casualty rates. If this were not true, appellant's operations in Arizona, which shared with Nevada the appellant's program of improvement in road and equipment, would have shown relatively the same rate of decrease in train and train-service accidents during and following that program of improvement; but this has not occurred, as we shall hereafter show. Also, the Santa Fe, whose improvement program covered the entire line from Needles to Belen—part long-train and part short-train operation—would have shown the same or relatively the same ratio of improvement in both the long and short-train portion of that line; but this has not fol-

lowed, as pointed out in Finding XII(k) (R. 4004-4006), which we shall later discuss.

Negligence of employes is the major factor in the production of train and train-service accidents. See Exhibits 270 (R. 3310-3335), 271 (R. 3336-3348), and 312 (R. 2266-2267), discussed and summarized in Finding XII(e) "Commission's Investigation of Train Accidents—National" (R. 3982-3983). Improvements in roadbed and equipment can have had but a negligible part in lessening such negligence, while the use of a lesser number of train units to handle a given volume of freight or passenger traffic will obviously have a great effect in lessening accidents due to negligence, because less opportunities are thereby provided for human failure. Casualties to individuals caused by their momentary forgetfulness or inattention, or that of fellow-employes, of which there are a number of classes and a large volume, are increased by an increased number of men employed. The fewer train units that are run to handle a given volume of traffic, the less opportunity there is for such casualties; and the increase in the length of trains, both freight and passenger, has undoubtedly had that effect. These observations do not apply to train and enginemen exclusively. For example, the train dispatcher, skillful as he is, is only human, and the more meets and passes he has to carry in his mind or on his sheet, the more opportunity there is for serious oversight.

(1) All Employes (R. 3977):

This finding is based on Exhibit 262 (R. 3300), as explained by Mr. Sullivan in his testimony (R. 1937-1939,

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Defts. Ex. No. 262 (Witness J.J SULLIVAN)

CASUALTIES TO ALL CLASSES OF EMPLOYES ON DUTY
SUSTAINED IN TRAIN AND TRAIN-SERVICE ACCIDENTS
CLASS I RAILROADS OF THE UNITED STATES
REFLECTED BY STATISTICS OF THE INTERSTATE COMMERCE COMMISSION

YEARS 1923 TO 1939, INCLUSIVE

	Year	Total Car Miles (Thousands)	Total Train Miles (Thousands)	Total Locomotive Miles (Thousands)	Man-Hours Worked by All Employes (Thousands)	Casualties to All Classes of Employes on Duty in Train and Train-Service Accidents			Casualty Rate Per			
						Killed	Injured	Total	100 Million Car Miles	Million Train Miles	Million Locomotive Miles	Million Man-Hours
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)
(1)	1923	29 432 500	1 245 099	1 756 170	4 856 983	1 507	38 520	40 027	136.00	32.15	22.79	8.24
(2)	1924	28 889 085	1 204 302	1 672 584	4 472 049	1 131	31 302	32 433	112.27	26.93	19.39	7.25
(3)	1925	30 785 543	1 220 846	1 697 798	4 458 702	1 180	31 275	32 455	105.42	26.58	19.12	7.28
(4)	1926	32 666 043	1 248 897	1 778 071	4 567 481	1 249	32 907	34 156	104.56	27.35	19.21	7.48
(5)	1927	32 462 178	1 220 987	1 728 040	4 416 147	1 121	27 085	28 206	86.89	23.10	16.32	6.39
(6)	1928	32 994 940	1 202 678	1 698 744	4 200 547	916	22 854	23 770	72.04	19.76	13.99	5.66
(7)	TOTAL 1923-28	187 230 289	7 342 809	10 331 407	26 971 909	7 104	183 943	191 047	AVERAGE 102.04	AVERAGE 26.02	AVERAGE 18.49	AVERAGE 7.08
(8)	1929	33 828 943	1 214 360	1 731 883	4 234 806	1 037	21 228	22 265	65.82	18.33	12.86	5.26
(9)	1930	30 177 596	1 106 386	1 550 246	3 648 890	690	13 033	13 723	45.47	12.40	8.85	3.76
(10)	1931	25 608 792	965 181	1 327 467	2 937 370	472	9 077	9 549	37.29	9.89	7.19	3.25
(11)	1932	20 350 867	821 158	1 104 953	2 291 540	414	6 943	7 357	36.15	8.96	6.66	3.21
(12)	1933	20 597 254	786 720	1 080 016	2 117 011	371	5 970	6 341	30.79	8.06	5.87	3.00
(13)	1934	22 179 787	818 473	1 124 043	2 267 515	372	6 252	6 624	29.87	8.09	5.89	2.92
(14)	TOTAL 1929-34	152 743 239	5 712 278	7 918 608	17 497 132	3 356	62 503	65 859	AVERAGE 43.12	AVERAGE 11.53	AVERAGE 8.32	AVERAGE 3.76
(15)	1935	22 512 343	829 198	1 149 494	2 265 664	413	6 195	6 608	29.35	7.97	5.76	2.92
(16)	1936	25 588 229	905 749	1 285 048	2 531 764	519	8 246	8 765	34.25	9.68	6.82	3.46
(17)	1937	26 848 096	933 219	1 310 646	2 646 909	582	8 433	9 015	33.58	9.66	6.88	3.41
(18)	1938	23 141 532	825 682	1 132 482	2 192 822	339	5 906	6 245	26.99	7.56	5.51	2.85
(19)	1939	25 258 741	853 179	1 190 362	2 342 153	353	6 360	6 713	26.58	7.87	5.64	2.87
(20)	TOTAL 1935-39	123 348 941	4 347 027	6 068 032	11 979 312	2 206	35 140	37 346	AVERAGE 30.28	AVERAGE 8.59	AVERAGE 6.15	AVERAGE 3.12
(21)	GRAND TOTAL 1923-39	463 322 469	17 402 114	24 318 047	56 448 353	12 666	281 586	294 252	AVERAGE 63.51	AVERAGE 16.91	AVERAGE 12.10	AVERAGE 5.21

COMPARISONS OF AVERAGE CASUALTY RATES

	Year	(Thousands)	(Thousands)	(Thousands)	(Thousands)	Killed	Injured	Total	Per Million Train Miles			
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)
(1)	1923	29 432 500	1 245 099	1 756 170	4 856 983	1 507	38 520	40 027	136.00	32.15	22.79	8.24
(2)	1924	28 889 085	1 204 302	1 672 584	4 472 049	1 131	31 302	32 433	112.27	26.93	19.39	7.25
(3)	1925	30 785 543	1 220 846	1 697 798	4 458 702	1 180	31 275	32 455	105.42	26.58	19.12	7.28
(4)	1926	32 666 043	1 248 897	1 778 071	4 567 481	1 249	32 907	34 156	104.56	27.35	19.21	7.48
(5)	1927	32 462 178	1 220 987	1 728 040	4 416 147	1 121	27 085	28 206	86.89	23.10	16.32	6.39
(6)	1928	32 994 940	1 202 678	1 698 744	4 200 547	916	22 854	23 770	72.04	19.76	13.99	5.66
(7)	TOTAL 1923-28	187 230 289	7 342 809	10 331 407	26 971 909	7 104	183 943	191 047	AVERAGE 102.04	AVERAGE 26.02	AVERAGE 18.49	AVERAGE 7.08
(8)	1929	33 828 943	1 214 360	1 731 883	4 234 806	1 037	21 228	22 265	65.82	18.33	12.86	5.26
(9)	1930	30 177 596	1 106 386	1 550 246	3 648 890	690	13 033	13 723	45.47	12.40	8.85	3.76
(10)	1931	25 608 792	965 181	1 327 467	2 937 370	472	9 077	9 549	37.29	9.89	7.19	3.25
(11)	1932	20 350 867	821 158	1 104 953	2 291 540	414	6 943	7 357	36.15	8.96	6.66	3.21
(12)	1933	20 597 254	786 720	1 080 016	2 117 011	371	5 970	6 341	30.79	8.06	5.87	3.00
(13)	1934	22 179 787	818 473	1 124 043	2 267 515	372	6 252	6 624	29.87	8.09	5.89	2.92
(14)	TOTAL 1929-34	152 743 239	5 712 278	7 918 608	17 497 132	3 356	62 503	65 859	AVERAGE 43.12	AVERAGE 11.53	AVERAGE 8.32	AVERAGE 3.76
(15)	1935	22 512 343	829 198	1 149 494	2 265 664	413	6 195	6 608	29.35	7.97	5.75	2.92
(16)	1936	25 588 229	905 749	1 285 048	2 531 764	519	8 246	8 765	34.25	9.68	6.82	3.46
(17)	1937	26 848 096	933 219	1 310 646	2 646 909	582	8 433	9 015	33.58	9.66	6.88	3.41
(18)	1938	23 141 532	825 682	1 132 482	2 192 822	339	5 906	6 245	26.99	7.56	5.51	2.85
(19)	1939	25 258 741	853 179	1 190 362	2 342 153	353	6 360	6 713	26.58	7.87	5.64	2.87
(20)	TOTAL 1935-39	123 348 941	4 347 027	6 068 032	11 979 312	2 206	35 140	37 346	AVERAGE 30.28	AVERAGE 8.59	AVERAGE 6.15	AVERAGE 3.12
(21)	GRAND TOTAL 1923-39	463 322 469	17 402 114	24 318 047	56 448 353	12 666	281 586	294 252	AVERAGE 63.51	AVERAGE 16.91	AVERAGE 12.10	AVERAGE 5.21
	COMPARISONS OF AVERAGE CASUALTY RATES											
(22)	PERIOD 1929 - 34 COMPARED WITH PERIOD 1923 - 28 - DECREASE								57.74%	55.69%	55.00%	46.89%
(23)	PERIOD 1935 - 39 COMPARED WITH PERIOD 1929 - 34 - DECREASE								29.78%	25.50%	26.08%	17.02%
(24)	PERIOD 1935 - 39 COMPARED WITH PERIOD 1923 - 28 - DECREASE								70.33%	66.99%	66.74%	55.93%

SOURCE: Column (b) - I.C.C. Statistics of Railways in the United States, Statement 31 in issue of 1928 for years 1923 to 1928 inclusive; table No. 55 issue of 1938 for years 1929 to 1938, inclusive. Preliminary Abstract of Railway Statistics for Year 1939.

Column (c) - I.C.C. Statistics of Railways in the United States, Statement No. 30 issue of 1928 for years 1923 to 1928 inclusive; table No. 53 issue of 1938 for years 1929 to 1938 inclusive. Preliminary Abstract of Railway Statistics for Year 1939

Column (d) - I.C.C. Annual Accident Bulletins, Table No. 101 for years 1923 and 1924; Table No. 97 for subsequent years.

Column (e) - (f) - (g) - I.C.C. Annual Accident Bulletins, Table No. 55.

2107-2108). The casualty rates, 1923-1939, are computed on the four bases of car miles, train miles, locomotive miles, and man hours. The exhibit relates to casualties to all classes of employes on duty sustained in train and train service accidents. Man hours were added to the other three bases, because the work of such employes as section foremen, section laborers and extra gangs engaged in construction work, track walkers, signal supervisors and maintainers, station forces, etc., is in connection with the movement of trains which they themselves do not take any part in operating. This work is measured by hours, not by accomplishment. There is a hazard in their employment, as the detailed statistics show, which arises from the possibility of being struck or run over by a train, and, of course, an increase in train miles correspondingly increases that hazard. The exhibit includes train and enginemen as well as the employes just referred to. It deserves study, and for that reason we insert it opposite this page. It shows (line 20) that for the five-year period, 1935-1939, the average casualty rate for all classes of employes on duty who are subject to being killed or injured in train and train service accidents was less than one-third of what it was in the years 1923-1928, on the car-mile basis (30.28 to 102.04); less than one-third on the train-mile basis (8.59 to 26.02); about one-third on the locomotive-mile basis (6.15 to 18.49), and less than one-half on the man-hour basis (3.12 to 7.08). The comparisons of average casualty rates in lines 22, 23 and 24 of the exhibit are also striking.

(2) Road Trainmen and Enginemen on Duty, all classes (R. 3977-3978):

This finding is based on Exhibit 263 (R. 3301), prepared and offered by Mr. Sullivan (R. 1944-1947). For convenient reference we insert the entire exhibit opposite this page.

As stated before, the car-mile basis is the most accurate basis for determining casualty rates in comparing one method of freight operation with another as we are here doing, especially when the transition from the operation of so-called short trains as a standard practice was gradual over a period of years while the plant was being fully prepared for the long-train operation, when there then came the full standard long-train operation which has continued to the present time. During the first or transitional six-year period, the average casualties were 53.11 per 100 million car miles, which dropped during the second six-year period to 23.16, and again during the five years ending with 1939 to 16.35, a total decline of 69.21 per cent on a car-mile basis; somewhat greater than the decline of 65.73 per cent during the same period on the train-mile basis; or the decline of 55.92 per cent on the man-hour basis.

(3) Road Freight Trainmen and Enginemen on Duty (R. 3978):

This classification narrows the comparisons by excluding all employes except those actually engaged in operating road freight trains, such as engineers, firemen, conductors, brakemen, and flagmen (rear brakemen), and is based on Exhibit 264, R. 3302 (a copy of which we insert opposite this page), and the explanatory testimony of Mr. Sullivan

Superior Court, Pima Co., Arizona
State v. S.P. Co. No. 20087

Defts. Ex. No. 263 (Witness J J SULLIVAN)

CASUALTIES TO ROAD TRAINMEN AND ENGINEMEN ON DUTY
ALL CLASSES OF SERVICE
SUSTAINED IN TRAIN AND TRAIN-SERVICE ACCIDENTS
CLASS I RAILROADS OF THE UNITED STATES
REFLECTED BY STATISTICS OF THE INTERSTATE COMMERCE COMMISSION
YEARS 1923 TO 1939, INCLUSIVE

	YEAR	TOTAL CAR MILES (Thousands)	TOTAL TRAIN MILES (Thousands)	MAN-HOURS WORKED BY ROAD TRAINMEN (Thousands)	CASUALTIES TO ROAD TRAINMEN ON DUTY IN TRAIN AND TRAIN SERVICE ACCIDENTS			CASUALTY RATE PER		
					KILLED	INJURED	TOTAL	100 MILLION CAR MILES	MILLION TRAIN MILES	MILLION MAN-HOURS
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
(1)	1923	29 432 500	1 245 099	499 275	545	21 093	21 638	73.52	17.38	43.34
(2)	1924	28 889 085	1 204 302	534 229	376	16 781	17 157	59.39	14.25	32.12
(3)	1925	30 785 543	1 220 846	529 615	388	16 262	16 650	54.08	13.64	31.44
(4)	1926	32 666 043	1 248 897	540 739	403	16 918	17 321	53.02	13.87	32.03
(5)	1927	32 462 178	1 220 987	510 068	372	14 062	14 434	44.46	11.82	28.30
(6)	1928	32 994 940	1 202 678	481 525	275	11 959	12 234	37.08	10.17	25.41
(7)	Total 1923-28	187 230 289	7 342 809	3 095 451	2 359	97 075	99 434	Average 53.11	Average 13.54	Average 32.12
(8)	1929	33 828 943	1 214 360	482 244	325	10 838	11 163	33.00	9.19	23.15
(9)	1930	30 177 596	1 106 386	409 413	251	7 037	7 288	24.15	6.59	17.80
(10)	1931	25 608 792	965 181	332 460	187	5 113	5 300	20.70	5.49	15.94
(11)	1932	20 350 867	821 158	266 228	163	3 990	4 153	20.41	5.06	15.60
(12)	1933	20 597 254	786 720	256 904	155	3 435	3 590	17.43	4.56	13.97
(13)	1934	22 179 787	818 473	268 510	185	3 696	3 881	17.50	4.74	14.45
(14)	Total 1929-34	152 743 239	5 712 278	2 015 759	1 266	34 109	35 375	Average 23.16	Average 6.19	Average 17.55
(15)	1935	22 512 343	829 198	269 939	166	3 552	3 718	16.52	4.48	13.77
(16)	1936	25 588 229	905 749	306 789	212	4 637	4 849	18.95	5.35	15.81
(17)	1937	28 848 096	933 219	312 500	231	4 482	4 713	17.55	5.05	15.08
(18)	1938	23 141 532	825 682	261 282	164	3 207	3 371	14.57	4.08	12.90
(19)	1939	25 258 741	853 179	273 602	153	3 368	3 521	13.94	4.13	12.87
(20)	Total 1935-39	123 348 941	4 347 027	1 424 112	926	19 246	20 172	Average 16.35	Average 4.64	Average 14.16
(21)	Grand Total 1923-39	463 322 969	17 402 114	6 535 322	4 551	150 430	154 981	Average 33.45	Average 8.91	Average 23.71
	COMPARISONS OF AVERAGE CASUALTY RATES									
(22)	PERIOD 1929 - 1934 COMPARED WITH PERIOD 1923 - 1928,				DECREASE			56.39%	54.28%	45.36%
(23)	PERIOD 1935 - 1939 COMPARED WITH PERIOD 1929 - 1934,				DECREASE			29.40%	25.04%	19.32%
(24)	PERIOD 1935 - 1939 COMPARED WITH PERIOD 1923 - 1928,				DECREASE			69.21%	65.73%	55.92%

CASUALTIES TO ROAD TRAINMEN AND ENGINEMEN ON DUTY
ALL CLASSES OF SERVICE
SUSTAINED IN TRAIN AND TRAIN-SERVICE ACCIDENTS
CLASS I RAILROADS OF THE UNITED STATES
REFLECTED BY STATISTICS OF THE INTERSTATE COMMERCE COMMISSION
YEARS 1923 TO 1939, INCLUSIVE

	YEAR	TOTAL CAR MILES (Thousands)	TOTAL TRAIN MILES (Thousands)	MAN-HOURS WORKED BY ROAD TRAINMEN (Thousands)	CASUALTIES TO ROAD TRAINMEN ON DUTY IN TRAIN AND TRAIN SERVICE ACCIDENTS			CASUALTY RATE PER		
					KILLED	INJURED	TOTAL	100 MILLION CAR MILES	MILLION TRAIN MILES	MILLION MAN-HOURS
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
(1)	1923	29 432 500	1 245 099	499 275	545	21 093	21 638	73.52	17.38	43.34
(2)	1924	28 889 085	1 204 302	534 229	376	16 781	17 157	59.39	14.25	32.12
(3)	1925	30 785 543	1 220 846	529 615	388	16 262	16 650	54.08	13.64	31.44
(4)	1926	32 666 043	1 248 897	540 739	403	16 918	17 321	53.02	13.87	32.03
(5)	1927	32 462 178	1 220 987	510 068	372	14 062	14 434	44.46	11.82	28.30
(6)	1928	32 994 940	1 202 678	481 525	275	11 959	12 234	37.08	10.17	25.41
(7)	Total 1923-28	187 230 289	7 342 809	3 095 451	2 359	97 075	99 434	Average 53.11	Average 13.54	Average 32.12
(8)	1929	33 828 943	1 214 360	482 244	325	10 838	11 163	33.00	9.19	23.15
(9)	1930	30 177 596	1 106 386	409 413	251	7 037	7 288	24.15	6.59	17.80
(10)	1931	25 608 792	965 181	332 460	187	5 113	5 300	20.70	5.49	15.94
(11)	1932	20 350 867	821 158	266 228	163	3 990	4 153	20.41	5.06	15.60
(12)	1933	20 597 254	786 720	256 904	155	3 435	3 590	17.43	4.56	13.97
(13)	1934	22 179 787	818 473	268 510	185	3 696	3 881	17.50	4.74	14.45
(14)	Total 1929-34	152 743 239	5 712 278	2 015 759	1 266	34 109	35 375	Average 23.16	Average 6.19	Average 17.55
(15)	1935	22 512 343	829 198	269 939	166	3 552	3 718	16.52	4.48	13.77
(16)	1936	25 588 229	905 749	306 789	212	4 637	4 849	18.95	5.35	15.81
(17)	1937	26 848 096	933 219	312 500	231	4 482	4 713	17.55	5.05	15.08
(18)	1938	23 141 532	825 682	261 282	164	3 207	3 371	14.57	4.08	12.90
(19)	1939	25 258 741	853 179	273 602	153	3 368	3 521	13.94	4.13	12.87
(20)	Total 1935-39	123 348 941	4 347 027	1 424 112	926	19 246	20 172	Average 16.35	Average 4.64	Average 14.16
(21)	Grand Total 1923-39	463 322 469	17 402 114	6 535 322	4 551	150 430	154 981	Average 33.45	Average 8.91	Average 23.71
	COMPARISONS OF AVERAGE CASUALTY RATES									
(22)	PERIOD 1929 - 1934 COMPARED WITH PERIOD 1923 - 1928, DECREASE							56.39%	54.28%	45.36%
(23)	PERIOD 1935 - 1939 COMPARED WITH PERIOD 1929 - 1934, DECREASE							29.40%	25.04%	19.32%
(24)	PERIOD 1935 - 1939 COMPARED WITH PERIOD 1923 - 1928, DECREASE							69.21%	65.73%	55.92%

NOTE: Road Trainmen and Enginemen, includes conductors, brakemen, flagmen, baggagemen, engineers and firemen.

SOURCE: Column (b), I.C.C. Statistics of Railways in the United States, Statement No. 31 issue of 1928 for years 1923 to 1928, inclusive; table No. 55 issue of 1938 for years 1929 to 1938, inclusive. Preliminary Abstract of Railway Statistics for year 1939.

Column (c), I.C.C. Statistics of Railways in the United States, statement No. 30 issue of 1928 for years 1923 to 1928; table No. 53 issue of 1938 for years 1929 to 1938, inclusive. Preliminary Abstract of Railway Statistics for year 1939.

Columns (d), (e) and (f), I.C.C. Annual Accident Bulletins, Table No. 55.

Superior Court, Pima Co., Arizona
State v. S.P. Co. No. 20087

Defts. Ex. No. 264 (Witness J J SULLIVAN)

CASUALTIES TO ROAD FREIGHT TRAINMEN AND ENGINEMEN ON DUTY

SUSTAINED IN TRAIN AND TRAIN-SERVICE ACCIDENTS
CLASS I RAILROADS OF THE UNITED STATES
REFLECTED BY STATISTICS OF THE INTERSTATE COMMERCE COMMISSION
YEARS 1923 TO 1939, INCLUSIVE

	YEAR	TOTAL FREIGHT TRAIN AND WORK TRAIN CAR MILES (Thousands)	TOTAL FREIGHT TRAIN AND WORK TRAIN TRAIN MILES (Thousands)	MAN-HOURS WORKED BY ROAD FREIGHT TRAINMEN AND ENGINEMEN (Thousands)	CASUALTIES TO ROAD FREIGHT TRAINMEN AND ENGINEMEN ON DUTY, IN TRAIN AND TRAIN-SERVICE ACCIDENTS			CASUALTY RATE PER		
					KILLED	INJURED	TOTAL	100 MILLION CAR MILES	MILLION TRAIN MILES	MILLION MAN-HOURS
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
(1)	1923	25 797 580	678 898	460 561	436	17 778	18 214	70.60	26.83	39.55
(2)	1924	25 193 036	633 288	401 340	295	13 955	14 250	56.56	22.50	35.51
(3)	1925	26 990 496	646 304	399 608	292	13 710	14 002	51.88	21.66	35.04
(4)	1926	28 780 342	670 458	412 781	311	14 270	14 581	50.66	21.75	35.32
(5)	1927	28 581 119	647 534	385 660	298	11 851	12 149	42.51	18.76	31.50
(6)	1928	29 145 755	636 469	362 306	197	9 970	10 167	34.88	15.97	28.06
(7)	Total 1923-28	164 488 328	3 912 951	2 422 256	1 829	81 534	83 363	Average 50.68	Average 21.30	Average 34.42
(8)	1929	29 922 710	648 909	364 808	247	9 118	9 365	31.30	14.43	25.67
(9)	1930	26 450 708	563 262	299 734	195	5 906	6 101	23.07	10.83	20.35
(10)	1931	22 290 854	479 632	237 583	136	4 213	4 349	19.51	9.07	18.31
(11)	1932	17 550 925	400 512	187 178	117	3 286	3 403	19.39	8.50	18.18
(12)	1933	18 030 948	403 619	186 302	104	2 883	2 987	16.57	7.40	16.03
(13)	1934	19 531 651	434 073	198 272	135	3 109	3 244	16.61	7.47	16.36
(14)	Total 1929-34	133 777 796	2 930 007	1 473 877	934	28 515	29 449	Average 22.01	Average 10.05	Average 19.98
(15)	1935	19 801 769	440 865	199 897	141	2 998	3 139	15.85	7.12	15.70
(16)	1936	22 756 196	501 073	233 074	178	3 929	4 099	18.01	8.18	17.59
(17)	1937	23 853 441	516 834	237 171	193	3 772	3 965	16.62	7.67	16.72
(18)	1938	20 309 599	431 891	191 014	122	2 631	2 753	13.56	6.37	14.41
(19)	1939	22 378 131	462 296	204 884	123	2 885	3 008	13.44	6.51	14.68
(20)	Total 1935-39	109 099 136	2 352 959	1 066 040	749	16 215	16 964	Average 15.55	Average 7.21	Average 15.91
(21)	Grand Total 1923-39	407 365 260	9 195 917	4 962 173	3 512	126 264	129 776	Average 31.86	Average 14.11	Average 26.15
	COMPARISONS OF AVERAGE CASUALTY RATES									
(22)	PERIOD 1929 - 1934 COMPARED WITH PERIOD 1923 - 1928, DECREASE							56.55%	52.82%	41.95%
(23)	PERIOD 1935 - 1939 COMPARED WITH PERIOD 1929 - 1934, DECREASE							29.35%	28.26%	20.37%
(24)	PERIOD 1935 - 1939 COMPARED WITH PERIOD 1923 - 1928, DECREASE							69.32%	66.15%	53.78%

CASUALTIES TO ROAD FREIGHT TRAINMEN AND ENGINEMEN ON DUTY

SUSTAINED IN TRAIN AND TRAIN-SERVICE ACCIDENTS
CLASS I RAILROADS OF THE UNITED STATES
REFLECTED BY STATISTICS OF THE INTERSTATE COMMERCE COMMISSION
YEARS 1923 TO 1939, INCLUSIVE

	YEAR	TOTAL FREIGHT TRAIN AND WORK TRAIN CAR MILES (Thousands)	TOTAL FREIGHT TRAIN AND WORK TRAIN MILES (Thousands)	MAN-HOURS WORKED BY ROAD FREIGHT TRAINMEN AND ENGINEMEN (Thousands)	CASUALTIES TO ROAD FREIGHT TRAINMEN AND ENGINEMEN ON DUTY, IN TRAIN AND TRAIN-SERVICE ACCIDENTS			CASUALTY RATE PER		
					KILLED	INJURED	TOTAL	100 MILLION CAR MILES	MILLION TRAIN MILES	MILLION MAN-HOURS
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
(1)	1923	25 797 580	678 898	460 561	436	17 778	18 214	70.60	26.83	39.55
(2)	1924	25 193 036	633 288	401 340	295	13 955	14 250	56.56	22.50	35.51
(3)	1925	26 990 496	646 304	399 608	292	13 710	14 002	51.88	21.66	35.04
(4)	1926	28 780 342	670 458	412 781	311	14 270	14 581	50.66	21.75	35.32
(5)	1927	28 581 119	647 534	385 660	298	11 851	12 149	42.51	18.76	31.50
(6)	1928	29 145 755	636 469	362 306	197	9 970	10 167	34.88	15.97	28.06
(7)	Total 1923-28	164 488 328	3 912 951	2 422 256	1 829	81 534	83 363	Average 50.68	Average 21.30	Average 34.42
(8)	1929	29 922 710	648 909	364 808	247	9 118	9 365	31.30	14.43	25.67
(9)	1930	26 450 708	563 262	299 734	195	5 906	6 101	23.07	10.83	20.35
(10)	1931	22 290 854	479 632	237 583	136	4 213	4 349	19.51	9.07	18.31
(11)	1932	17 550 925	400 512	187 178	117	3 286	3 403	19.39	8.50	18.18
(12)	1933	18 030 948	403 619	186 302	104	2 883	2 987	16.57	7.40	16.03
(13)	1934	19 531 651	434 073	198 272	135	3 109	3 244	16.61	7.47	16.36
(14)	Total 1929-34	133 777 796	2 930 007	1 473 877	934	28 515	29 449	Average 22.01	Average 10.05	Average 19.98
(15)	1935	19 803 769	440 865	199 897	141	2 998	3 139	15.85	7.12	15.70
(16)	1936	22 756 196	501 073	233 074	170	3 929	4 099	18.01	8.18	17.59
(17)	1937	23 853 441	516 834	237 171	193	3 772	3 965	16.62	7.67	16.72
(18)	1938	20 309 599	431 891	191 014	122	2 631	2 753	13.56	6.37	14.41
(19)	1939	22 378 131	462 296	204 884	119	2 885	3 008	13.44	6.51	14.68
(20)	Total 1935-39	109 099 136	2 352 959	1 066 040	749	16 215	16 964	Average 15.55	Average 7.21	Average 15.91
(21)	Grand Total 1923-39	407 365 260	9 195 917	4 962 173	3 512	126 264	129 776	Average 31.86	Average 14.11	Average 26.15
	COMPARISONS OF AVERAGE CASUALTY RATES									
(22)	PERIOD 1929 - 1934 COMPARED WITH PERIOD 1923 - 1928, DECREASE							56.55%	52.82%	41.95%
(23)	PERIOD 1935 - 1939 COMPARED WITH PERIOD 1929 - 1934, DECREASE							29.35%	28.26%	20.37%
(24)	PERIOD 1935 - 1939 COMPARED WITH PERIOD 1923 - 1928, DECREASE							69.12%	66.15%	53.78%

SOURCE: Column (b), I.C.C. Statistics of Railways in the United States, statement No. 31 in issue of 1935 for years 1923 to 1935 inclusive; table No. 55 for years 1936 and 1937; table No. 158 for year 1938. Preliminary Abstract of Railway Statistics for Year 1939.

Column (c), I.C.C. Statistics of Railways in the United States, statement No. 30 in issue of 1928 for years 1923 to 1928 inclusive; table No. 53 in issue of 1938 for years 1929 to 1938 inclusive. Preliminary Abstract of Railway Statistics for Year 1939.

Columns (d), (e) and (f), I.C.C. Annual Accident Bulletins, table No. 55

Superior Court, Pima Co., Arizona
State v. S.P. Co. No. 20087

Defts. Ex. No. 265 (Witness J.J. SULLIVAN)

CASUALTIES TO ROAD FREIGHT CONDUCTORS, BRAKEMEN AND FLAGMEN ON DUTY
SUSTAINED IN TRAIN AND TRAIN-SERVICE ACCIDENTS
CLASS I RAILROADS OF THE UNITED STATES
REFLECTED BY STATISTICS OF THE INTERSTATE COMMERCE COMMISSION
YEARS 1923 TO 1939, INCLUSIVE

	YEAR	TOTAL FREIGHT TRAIN AND WORK TRAIN CAR MILES (Thousands)	TOTAL FREIGHT TRAIN AND WORK TRAIN TRAIN MILES (Thousands)	MAN-HOURS WORKED BY ROAD FREIGHT CONDUCTORS, BRAKEMEN, AND FLAGMEN (Thousands)	CASUALTIES TO ROAD FREIGHT CONDUCTORS, BRAKEMEN AND FLAGMEN ON DUTY IN TRAIN & TRAIN-SERVICE ACCIDENTS			CASUALTY RATE PER		
					KILLED	INJURED	TOTAL	100 MILLION CAR MILES	MILLION TRAIN MILES	MILLION MAN-HOURS
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
(1)	1923	25 797 580	678 898	268 548	322	11 910	12 232	47.42	18.02	45.33
(2)	1924	25 193 036	633 288	234 752	215	9 838	10 053	39.90	15.87	42.82
(3)	1925	26 990 496	646 304	232 998	228	9 855	10 083	37.36	15.60	43.28
(4)	1926	28 780 342	670 458	239 990	256	10 282	10 538	36.62	15.72	43.91
(5)	1927	28 581 119	647 534	224 081	215	8 876	9 091	31.81	14.04	40.57
(6)	1928	29 145 755	636 469	210 124	163	7 662	7 825	26.85	12.29	37.24
(7)	Total 1923-28	164 488 328	3 912 951	1 410 493	1 399	58 423	59 822	Average 36.37	Average 15.29	Average 42.41
(8)	1929	29 922 710	648 909	211 276	176	6 910	7 086	23.68	10.92	33.54
(9)	1930	26 450 708	563 262	173 888	152	4 587	4 739	17.92	8.41	27.25
(10)	1931	22 290 854	479 632	137 510	109	3 275	3 384	15.18	7.06	24.61
(11)	1932	17 550 925	400 512	107 909	97	2 586	2 683	15.29	6.70	24.86
(12)	1933	18 030 948	403 619	106 829	82	2 283	2 365	13.12	5.86	22.14
(13)	1934	19 531 651	434 073	113 645	106	2 460	2 566	13.14	5.91	22.58
(14)	Total 1929-34	133 777 796	2 930 007	851 057	722	22 101	22 823	Average 17.06	Average 7.79	Average 26.82
(15)	1935	19 801 769	440 865	114 415	105	2 403	2 508	12.67	5.69	21.92
(16)	1936	22 756 196	501 073	133 026	125	3 119	3 244	14.26	6.47	24.39
(17)	1937	23 853 441	516 834	135 565	138	2 973	3 111	13.04	6.02	22.95
(18)	1938	20 309 599	431 891	109 601	92	2 069	2 161	10.64	5.00	19.72
(19)	1939	22 378 131	462 296	117 045	86	2 294	2 380	10.64	5.15	20.33
(20)	Total 1935-39	109 099 136	2 352 959	609 652	546	12 858	13 404	Average 12.29	Average 5.70	Average 21.99
(21)	Grand Total 1923-39	407 365 260	9 195 917	2 871 202	2 667	93 382	96 049	Average 23.58	Average 10.44	Average 33.45

COMPARISONS OF AVERAGE CASUALTY RATES

	YEAR	TOTAL FREIGHT TRAIN AND WORK TRAIN CAR MILES (Thousands)	TOTAL FREIGHT TRAIN AND WORK TRAIN TRAIN MILES (Thousands)	WORKED BY ROAD FREIGHT CONDUCTORS, BRAKEMEN, AND FLAGMEN (Thousands)	CASUALTIES TO ROAD FREIGHT CONDUCTORS, BRAKEMEN AND FLAGMEN ON DUTY IN TRAIN & TRAIN-SERVICE ACCIDENTS			CASUALTY RATE PER		
					KILLED	INJURED	TOTAL	100 MILLION CAR MILES	MILLION TRAIN MILES	MILLION MAN-HOURS
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
(1)	1923	25 797 580	678 898	268 548	322	11 910	12 232	47.42	18.02	45.33
(2)	1924	25 193 036	633 288	234 752	215	9 838	10 053	39.90	15.87	42.82
(3)	1925	26 990 496	646 304	232 998	228	9 855	10 083	37.36	15.60	43.28
(4)	1926	28 780 342	670 458	239 990	256	10 282	10 538	36.62	15.72	43.91
(5)	1927	28 581 119	647 534	224 081	215	8 876	9 091	31.81	14.04	40.57
(6)	1928	29 145 755	636 469	210 124	163	7 662	7 825	26.85	12.29	37.24
(7)	Total 1923-28	164 488 328	3 912 951	1 410 493	1 399	58 423	59 822	Average 36.37	Average 15.29	Average 42.41
(8)	1929	29 922 710	648 909	211 276	176	6 910	7 086	23.68	10.92	33.54
(9)	1930	26 450 708	563 262	173 888	152	4 587	4 739	17.92	8.41	27.25
(10)	1931	22 290 854	479 632	137 510	109	3 275	3 384	15.18	7.06	24.61
(11)	1932	17 550 925	400 512	107 909	97	2 586	2 683	15.29	6.70	24.86
(12)	1933	18 030 948	403 619	106 829	82	2 283	2 365	13.12	5.86	22.14
(13)	1934	19 531 651	434 073	113 645	106	2 460	2 566	13.14	5.91	22.58
(14)	Total 1929-34	133 777 796	2 930 007	851 057	722	22 101	22 823	Average 17.06	Average 7.79	Average 26.82
(15)	1935	19 801 769	440 865	114 415	105	2 403	2 508	12.67	5.69	21.92
(16)	1936	22 756 196	501 073	133 026	125	3 119	3 244	14.26	6.47	24.39
(17)	1937	23 853 441	516 834	135 565	138	2 973	3 111	13.04	6.02	22.95
(18)	1938	20 309 599	431 891	109 601	92	2 069	2 161	10.64	5.00	19.72
(19)	1939	22 378 131	462 296	117 045	86	2 294	2 380	10.64	5.15	20.33
(20)	Total 1935-39	109 099 136	2 352 959	609 652	546	12 858	13 404	Average 12.29	Average 5.70	Average 21.99
(21)	Grand Total 1923-39	407 365 260	9 195 917	2 871 202	2 667	93 382	96 049	Average 23.58	Average 10.44	Average 33.45
	COMPARISONS OF AVERAGE CASUALTY RATES									
(22)	PERIOD 1929 - 1934 COMPARED WITH PERIOD 1923 - 1928,				DECREASE			53.09%	49.05%	36.76%
(23)	PERIOD 1935 - 1939 COMPARED WITH PERIOD 1929 - 1934,				DECREASE			27.96%	26.83%	18.01%
(24)	PERIOD 1935 - 1939 COMPARED WITH PERIOD 1923 - 1928,				DECREASE			66.21%	62.72%	48.15%

SOURCE: Column (b), I.C.C. Statistics of Railways in the United States, statement No. 31 in issue of 1935 for years 1923 to 1935 inclusive; table No. 55 for years 1936 and 1937; table No. 158 for year 1938. Preliminary Abstract of Railway Statistics for year 1939.

Column (c), I.C.C. Statistics of Railways in the United States, statement No. 30 in issue of 1928 for years 1923 to 1928; table No. 53 in issue of 1938 for years 1929 to 1938, inclusive. Preliminary Abstract of Railway Statistics for year 1939.

Columns (d), (e) and (f), I.C.C. Annual Accident Bulletins, table No. 5

(R. 1947-1948, 2109-2110). The same remarks as to trends and comparisons apply to this exhibit as to the preceding Exhibit 263. It is noteworthy that the decrease in average casualty rates for the period 1935-1939, compared with the period 1923-1928, is shown by line 24 of this exhibit to have been 69.32 per cent on the car-mile basis as compared with 69.21 per cent on the same basis for all road trainmen and enginemen on duty, as shown by line 24 of Exhibit 263. The other comparisons of decreases are relatively the same. In fact, considering the tremendous performances to which the casualties are applied in both of these exhibits—100 million car miles, one million train miles, one million man hours—it may fairly be said that the rate of decrease on any period-comparison is the same in both exhibits.

(4) Road Freight Conductors, Brakemen and Flagmen (R. 3978-3979):

This subfinding is based on Mr. Sullivan's testimony (R. 1949-1950) explaining his Exhibit 265 (R. 3303), a copy of which we insert opposite this page.

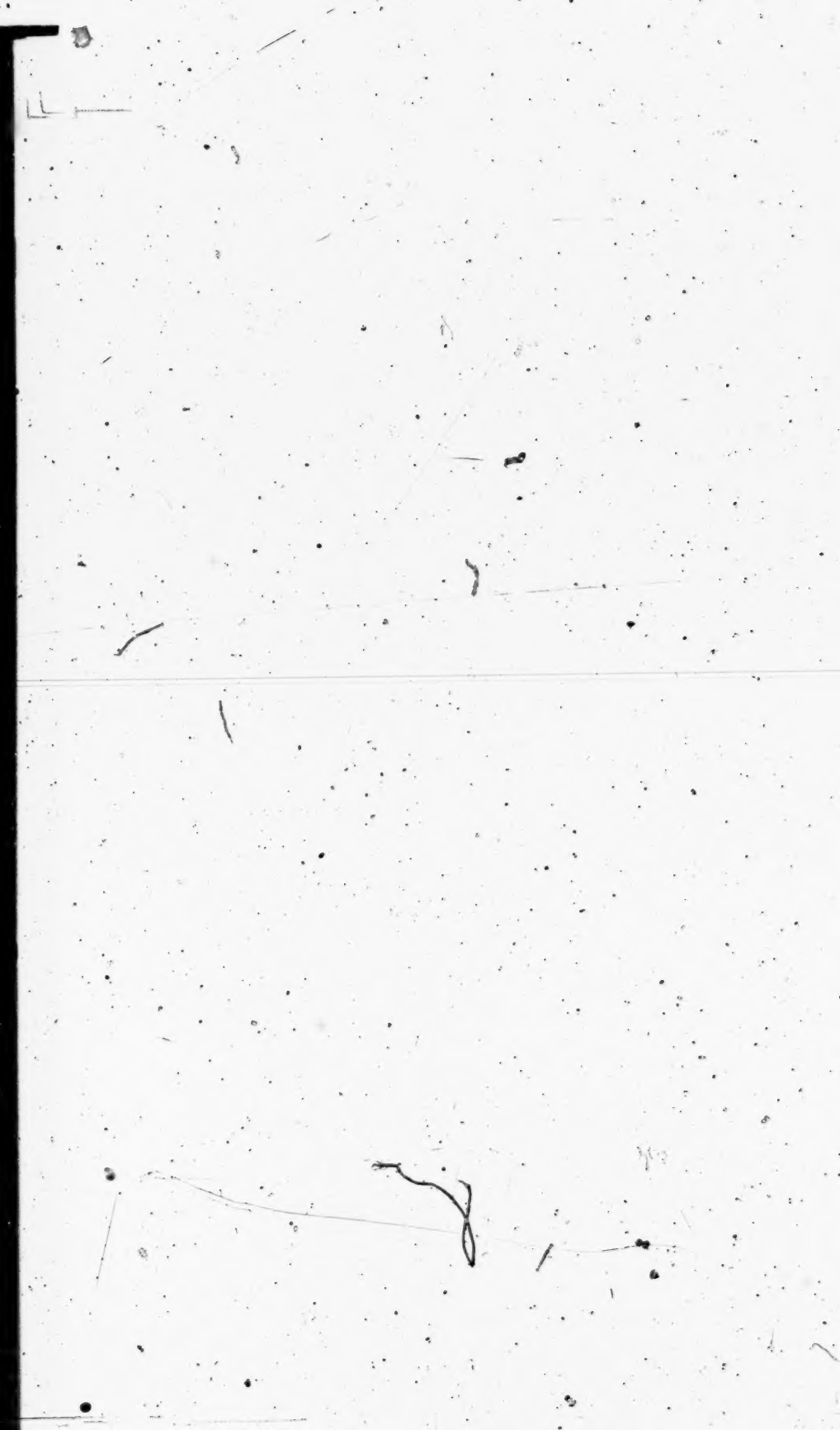
It further narrows the study to those classes of employes which have been claimed in all of the former train-limit cases, as well as in the Congressional hearings and hearings before State Legislatures, to be most directly and injuriously affected by the long-train method of operation; the claim being based on the theory that that method was productive of a substantially greater hazard from slack-action accident to these classes of employes than where the freight-train operation was limited to 70 cars or less. Such is the claim repeatedly advanced by appel-

lant as shown by its briefs at earlier stages of this case. We anticipated the challenge and were fully prepared to meet it. Again we say that the safety of a given method of freight-train operation is not to be judged by selecting one type of accident of comparatively infrequent occurrence, and which is produced, if at all, by the concurrence of a number of factors, practically all of which are potential in all freight train operation. The true criterion is that of the hazard from all causes which may produce death or personal injury to the class of employes under consideration. Exhibit 265 again shows the downward curve of casualty rates measured on any of the three bases, the curve on the car-mile basis quite naturally being steeper in its descent, for the reasons which we have perhaps tiresomely stated and reiterated.

When we compare the decreases in average casualty rates, as shown in lines 22, 23 and 24 of this exhibit, with the corresponding lines in Exhibits 263 and 264, we find a close correspondence between all three sets of percentages of decrease, a correspondence so close that, considering the great mass of performances to which the casualties in their aggregate are related, from a practical and realistic standpoint the occupational hazard of the classes of employees covered by Exhibit 265 is practically the same as that of the larger classes of which they form a part, who are covered in the two preceding exhibits.

(5) Conductors, Brakemen and Flagmen—Slack Action (R. 3979-3980):

This subfinding is based on Exhibit 266 (R. 3304), as explained by Mr. Sullivan at the time of its introduction (R. 1951-1955).



Superior Court, Pima Co., Arizona
State v. S.P.Co. No. 20087

Defts. Ex. No. 266 (Witness J.J. SULLIVAN)

CASUALTIES TO ROAD FREIGHT CONDUCTORS, BRAKEMEN AND FLAGMEN
TRAIN-SERVICE ACCIDENTS CAUSED BY
SUDDEN STOP, START, LURCH OR JERK OF LOCOMOTIVE, CAR OR TRAIN
ALL RAILROADS OF THE UNITED STATES
REFLECTED BY STATISTICS OF THE INTERSTATE COMMERCE COMMISSION
YEARS 1923 TO 1939, INCLUSIVE

	YEAR	TOTAL FREIGHT AND WORK TRAIN CAR MILES (Thousands)	TOTAL FREIGHT AND WORK TRAIN TRAIN MILES (Thousands)	CASUALTIES TO ROAD FREIGHT CONDUCTORS, BRAKEMEN AND FLAGMEN, CAUSED BY SUDDEN STOP, START, LURCH OR JERK OF TRAIN			CASUALTY RATE PER	
				KILLED	INJURED	TOTAL	100 MILLION CAR MILES	MILLION TRAIN MILES
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
(1)	1923	25,797,580	678,898	11	1,946	1,957	7.59	2.88
(2)	1924	25,193,036	633,288	8	1,667	1,675	6.65	2.64
(3)	1925	26,990,496	646,304	10	1,818	1,828	6.77	2.83
(4)	1926	28,780,342	670,458	8	1,922	1,930	6.71	2.88
(5)	1927	28,581,119	647,534	10	1,777	1,787	6.25	2.76
(6)	1928	29,145,755	636,469	6	1,571	1,577	5.41	2.48
(7)	TOTAL 1923-28	164,488,328	3,912,951	53	10,701	10,754	AVERAGE 6.54	2.75
(8)	1929	29,922,710	648,909	4	1,451	1,455	4.86	2.24
(9)	1930	26,450,708	563,262	5	971	976	3.69	1.73
(10)	1931	22,290,854	479,632	5	709	714	3.20	1.49
(11)	1932	17,550,925	400,512	4	499	503	2.87	1.26
(12)	1933	18,030,948	403,619	3	417	420	2.33	1.04
(13)	1934	19,531,651	434,073	3	493	496	2.54	1.14
(14)	TOTAL 1929-34	133,777,796	2,930,007	24	4,540	4,564	AVERAGE 3.41	1.56

(8)	1929	29,922,710	648,909	4	1,451	1,455	4.86	2.24
(9)	1930	26,450,708	563,262	5	971	976	3.69	1.73
(10)	1931	22,290,854	479,632	5	709	714	3.20	1.49
(11)	1932	17,550,925	400,512	4	499	503	2.87	1.26
(12)	1933	18,030,948	403,619	3	417	420	2.33	1.04
(13)	1934	19,531,651	434,073	3	493	496	2.54	1.14
(14)	TOTAL 1929-34	133,777,796	2,930,007	24	4,540	4,564	AVERAGE 3.41	1.56
(15)	1935	19,801,769	440,865	3	509	512	2.59	1.16
(16)	1936	22,756,196	501,073	3	671	674	2.96	1.35
(17)	1937	23,853,441	516,834	5	565	570	2.39	1.10
(18)	1938	20,309,599	431,891	2	316	318	1.57	.74
(19)	1939	22,378,131	462,296	3	396	399	1.78	.86
(20)	TOTAL 1935-39	109,099,136	2,352,959	16	2,457	2,473	AVERAGE 2.27	1.05
(21)	GRAND TOTAL 1923-39	407,365,260	9,195,917	93	17,698	17,791	AVERAGE 1.37	1.93

COMPARISONS OF AVERAGE CASUALTY RATES

(22)	PERIOD 1929 - 34 COMPARED WITH PERIOD 1923 - 28, DECREASE	47.86%	43.27%
(23)	PERIOD 1935 - 39 COMPARED WITH PERIOD 1929 - 34, DECREASE	33.43%	32.69%
(24)	PERIOD 1935 - 39 COMPARED WITH PERIOD 1923 - 28, DECREASE	65.29%	61.82%

SOURCE: Column (b)- I.C.C. Statistics of Railways in the United States, Statement No. 31 in issue of 1935 for years 1923 to 1935, inclusive; Table No. 55 for years 1936 and 1937; Table No. 158 for year 1938, Preliminary Abstract of Railway Statistics for year 1939.

Column (c)- I.C.C. Statistics of Railways in the United States, Statement No. 30 in issue of 1928 for years 1923 to 1928, inclusive; Table No. 53 in issue of 1938 for years 1929 to 1938, inclusive, Preliminary Abstract of Railway Statistics for year 1939.

Columns (d) and (e)- I.C.C. Annual Accident Bulletins, Table No. 80, Code Causes 7007, 7008, 7009 and 7010 combined.

A complete copy of that exhibit is inserted opposite this page. The title of the subfinding is relatively short, but the exhibit covers the years 1923 to 1939 inclusive, and is entitled "Casualties to Road Freight Conductors, Brakemen and Flagmen, from Train and Train Service Accidents Caused by Sudden Stop, Start, Lurch or Jerk of Locomotive, Car or Train: All Railroads of the United States".

The casualty rates are calculated on the bases of 100 million car miles and one million train miles.

First we call attention to the fact that in the 17 years covered by Exhibit 266 the total number of casualties from the code causes described in the title was 17,791 (line 21, column f), or 6 per cent of the 294,252 casualties to all classes of employes on duty, sustained in train and train service accidents during the same period, as shown in line 21, column h, of Exhibit 262, hereinbefore discussed and inserted.

During the first six years shown, 1923-1928, the rate per 100 million car miles in Exhibit 262 (line 7, column i) was 102.04, as contrasted with 6.54 in Exhibit 266 (line 7, column g), which was but 6.4 per cent of the all-employe casualty rate thus stated. That was during the transitional period from the short-freight-train method to the long-freight-train method of operation. A gradual decline is shown on both exhibits during the middle period, 1929-1934 inclusive; and a comparison of the last five years, 1935-1939, shows that of a total of 37,346 (line 20, column h, Exhibit 262) all-employe casualties in train and train-service accidents, there were but 2,473 accidents of

the character described in Exhibit 266 (line 20, column f) a percentage of 6.6 per cent. The average number of casualties per 100 million car miles, to all employes on duty (line 21, column i, Exhibit 262) was 30.28 during the latest five-year period; while Exhibit 266 shows that during the same period the corresponding rate for this particular type of casualty was but 2.27. It is apparent that the advocates of train-limit laws such as the Arizona statute are in reality proposing to increase the hazard of casualties in train and train-service accidents which inevitably accompanies an unnecessary increase in the number of trains run, for the sake of what is shown to be an ineffectual effort to minimize the occurrence of casualties which amounted to but 6.6 per cent of the total number sustained in train and train-service accidents during the five years ending with 1939. We are justified in using all casualties in train and train-service operation as a basis for this argument, even though those figures include passenger-train employe casualties, because both classes of trains are operated on the same tracks, have meets and passes, and the safety of their operation is directly affected by the number of trains of all classes operated in a particular district.

We again call attention to the comparison of average casualty rates on lines 22, 23 and 24 of Exhibit 266, with the corresponding figures in Exhibits 263, 264 and 265. For all practical purposes the decreases in the so-called slack action casualty rates have been practically the same, in percentages, as the decreases just mentioned; and the percentage trend as shown by Columns (h) and (i) in all

of the four exhibits, likewise descends as steeply in one as in any of the others.

We think it clear, taking the other evidence in the case into consideration, that a very important factor in the decrease of the slack-action accidents has been the running of less train miles to handle the same volume of traffic measured in car miles. The speed of a freight train is one of the factors that concurs with other factors in producing slack-action shock, and it is apparent from the testimony, and particularly the detailed list of accidents in Nevada and Arizona which usually show the speed of the train when casualties occur, that slack-action shocks are more severe at slow speeds than at higher speeds. When air-brakes are applied a car is decelerated in proportion to its speed. In running fewer trains to handle the same volume of traffic, a substantial increase in the average speed of freight trains has been attained, as shown by the evidence, and, what is more important in its bearing on slack-action accidents, long-train operation has necessitated fewer stops and startings of freight trains and fewer occasions for taking sidings to pass trains approaching on single track in the opposite direction, or to allow superior trains to overtake and pass on either single or double track. Thus the frequency of slack-action accidents in handling a given number of cars bears a direct relation to the number of trains operated to handle that volume of traffic; because the additional trains give more occasion to stop and start and take sidings.

As shown by Finding X(b), "Delays to Trains Enroute: Meets and Passes" (R. 3957-3958), in the year 1938 the

4,304 additional freight trains which the law compelled the appellant to run between Yuma and El Paso via Gila and Lordsburg entailed 16,512 additional meets and passes over and above those which would have occurred if long-freight-train operation had prevailed, an increase of about 63 per cent in meets and passes between all the trains, both freight and passenger, run in that territory.

These national statistics are particularly valuable in considering the hazard of slack-action accidents. There are, relative speaking, so few of those accidents during the year in any state on the appellant's Pacific Lines—as illustrated by the Nevada and Arizona comparative statistics—that a very few accidents of that character, causing slight and almost trivial disability, will weigh heavily in arriving at either the train-mile or the car-mile frequency rate in a given year or even in a period of two or three years. It is only when trends are considered, or a substantial period of time is taken, that dependable conclusions can be reached. The comparison of slack-action casualties in Arizona and Nevada, which later will be dealt with, illustrates this thought. But when one takes the accidents on all of the railroads of the United States, the absolute number in each year clearly indicates the minor importance, relatively speaking, of this class of casualties, and the trend eloquently speaks of their rapid decrease coincident with the running of fewer and consequently longer trains to handle the same volume of traffic.

(6) Passengers on Trains (R. 3980):

This sub-finding is based on Mr. Sullivan's Exhibit 267 (R. 3305), as explained in his testimony on pages 1959-1961 of the printed record.

Although there may have been some reason advanced for this law in 1912, as applied to passenger trains, we have yet to hear any one seriously suggest what it was. If there was one, it has long since vanished. The improvements in road bed and signals, as well as in passenger equipment, shown by the chronological exhibits 4 (R. 2854) and 6 (R. 2856), and by the similar exhibit 107 (R. 2960) relating to Pullman cars, are responsible. These improvements are shown by the testimony of the officials of the other sixteen railroads to correspond closely to those made in their own motive power and equipment. The testimony of Mr. Parke, Chief Engineer of The Pullman Company, is particularly illuminating, when it is considered that Pullman equipment is nationally used and is practically the only sleeping-car equipment in use (*Parke*, R. 787-798, 805-824). It was not seriously suggested, by cross-examination or in rebuttal, or indeed at any stage of the case, that there is any difficulty or hazard in handling passenger trains of substantially over fourteen cars; and that practice is shown by the evidence to be prevalent on all of the railroads whose testimony was presented. There is not the shadow of an argument in favor of the regulation of the length of passenger trains, not even the nebulous argument that revolves around slack action.

Exhibit 267 is on two different bases of calculation of casualty rates, neither of which for obvious reasons appears in any of the preceding exhibits. The number of passengers carried, no matter how far carried, and the number of revenue passengers carried one mile are given in separate Columns (b) and (c). The casualties are then

given, divided between train accidents and train-service accidents. The casualties in the aggregate are then related in Columns (m) and (n) to "million passengers carried" and "100 million passenger miles". Mr. Sullivan explained Exhibit 267 as follows (R. 1959-1960):

"Mr. Booth: In respect to the length of time of disability, how do the casualties shown in this exhibit; where they did not result in death, differ from those shown in the preceding exhibits insofar as they dealt with employes?

A. Well, as indicated in the note at the foot of the exhibit an injury to a passenger is reportable if the injury is sufficient to incapacitate the injured person from following his customary vocation or mode of living for a period of more than one day. In the case of employes, the injury is not reportable unless it disables the employe for more than three days within the ten days immediately following the occurrence of the accident.

Q. Under the reporting rules of the Commission, how are deaths to passengers handled in reporting the accident?

A. In the same manner as the deaths to any person. If death results within twenty-four hours after the occurrence of the accident, it is reported in the statistics as a person killed. If death results after the expiration of twenty-four hours, it is reported as a person injured and a report made of the subsequent fatality.

Q. You are shown the casualty rates by two methods, per million passengers carried and per hundred million passenger miles. Have you any observations you desire to make as to that?

A. Yes, million passengers carried represents the absolute number regardless of the distance that the individual passengers may have travelled. In order to give an idea as to the occurrence of accidents and the exposure to injury, generally, casualties are measured against the miles travelled by the passenger which is shown in column C, and the rate is shown in column N."

The exhibit shows that the average casualty rates, based either on the number of passengers carried or the number of passenger miles traversed, have remained fairly constant since 1923. This is largely accounted for by the fact that the great improvements in the strength and appurtenances of passenger equipment took place prior to that year. See Exhibit 4, "Chronology of Passenger Coach and Chair Cars", and Exhibit 107, "Chronology of Advances in Sleeping Car Construction of Cars Owned by The Pullman Company". These exhibits will be found among those inside the last cover page of this brief. The practice of handling through passenger trains, when and as traffic and operating conditions permit, in train units of substantially more than fourteen cars has apparently, considering Exhibit 267, failed to increase the hazard to passengers.

And finally, passenger train operation, considering the country as a whole, had evidently reached in 1940 a practically irreducible minimum of casualties to passengers, measured on any recognized basis.

(d) TRAIN ACCIDENTS—NATIONAL (R. 3980-3981).

Exhibit 269 (R. 3307) is the primary basis for the testimony (R. 1967-1970, 2760-2762) upon which the finding is predicated.

The exhibit is an elaborate study, in three sheets, showing on bases of car miles, train miles, and locomotive miles the number of train accidents by Interstate Commerce Commission classes, the number resulting in casualties, and the number of casualties occurring on all United States railroads during the years 1923-1939, inclusive. The third sheet of the exhibit relates these train accidents and their attendant casualties to car miles and train miles. The exhibit is fairly analyzed in the finding. We have few additional comments to make.

Sheet 3, Columns h, i, j, and k, relate the rear-end and head-end collisions, and the casualties occasioned thereby, to train miles and locomotive miles. The locomotive-mile basis is used because the locomotive is the active agent in a collision. During the five years 1935-1939, there was an improvement of 62 per cent in the frequency of such collisions, on the train-mile basis, and 61.76 per cent on the locomotive-mile basis; a result due largely, if not almost entirely, to the lesser number of the locomotives used to handle the traffic. The casualty rate to trainmen and enginemen during the same period declined 61.54 per cent on the train-mile basis, and 61.11 per cent on the locomotive-mile basis. The almost immediate effect on the frequency of collisions arising from the long-train method of operation is shown by comparing the averages for the first six years, while the long-train program was under

...ARY OF ACCIDENT INVESTIGATION REPORTS,
INTERSTATE COMMERCE COMMISSION - BUREAU OF SAFETY,
IN SO FAR AS IT RELATES TO ACCIDENTS INVOLVING ROAD FREIGHT TRAINS, INCLUDING MIXED TRAINS HANDLING FREIGHT CARS
YEARS 1928 TO 1939

I. C. C. BUREAU OF SAFETY SUMMARY OF ACCIDENT INVESTIGATION REPORTS NO.	PERIOD COVERED	TOTAL NUMBER OF ACCIDENTS ALL KINDS OF TRAINS INVESTIGATED	NUMBER OF ACCIDENTS INVESTIGATED INVOLVING FREIGHT TRAINS: TOTAL NUMBER INVOLVING FREIGHT TRAINS	COLLISIONS	DERAILMENTS	LOCOMOTIVE BOILER AND OTHER LOCOMOTIVE ACCIDENTS	MISCELLANEOUS	PERSONS KILLED	PERSONS INJURED	TOTAL NUMBER OF FREIGHT TRAINS INVOLVED AS TO VARIOUS LENGTHS: 40 AND LESS	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100	OVER 100	PRIMARY CAUSE OF ACCIDENT INVESTIGATED: DEFECTS IN OR FAILURES OF FRT. CARS	DEFECTS IN OR FAILURES OF LOCOMOTIVES	DEFECTS IN OR FAILURES OF MofW & STRUCTURES	ALL OTHER CAUSES EXCEPT NEGLIGENCE	NEGLIGENCE OF EMPLOYES: CONDUCTORS & BRAKEMEN	ENGINEERS & FIREMEN	JOINT TRAINMEN & ENGINEMEN	TRAIN DISPATCHERS & OPERATORS	ED
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	
67	Jan. to Mar. 1936	28	16	8	8	-	-	21	64	12	1	4	2	-	-	-	2	5	-	-	3	2	1	4	-	
68	Apr. to June 1936	18	13	6	7	-	-	14	219	9	2	2	1	-	-	-	1	1	1	-	4	-	3	1	-	
69	July to Sept 1936	28	15	6	9	-	-	24	44	8	3	3	2	-	1	-	-	2	1	2	3	2	2	1	-	
70	Oct. to Dec. 1936	27	18	13	5	-	-	24	68	14	1	2	6	2	2	1	1	3	-	1	2	3	1	6	1	
	TOTAL YEAR 1936	101	62	33	29	-	-	83	395	43	7	11	11	2	3	1	4	11	2	3	12	7	7	12	1	
71	Jan. to Mar. 1937	36	26	19	7	-	-	29	117	15	5	3	4	1	2	1	2	1	-	2	1	4	8	7	-	
72	Apr. to June 1937	18	8	2	6	-	-	7	15	3	4	1	-	-	-	1	-	2	-	2	-	-	2	-	-	
73	July to Sept 1937	17	12	5	7	-	-	20	32	11	1	2	-	-	-	-	-	1	-	-	3	1	2	3	-	
74	Oct. to Dec. 1937	39	21	11	10	-	-	31	62	13	2	4	-	4	2	-	1	4	-	-	6	1	2	5	-	
	TOTAL YEAR 1937	110	67	37	30	-	-	87	226	45	12	10	4	5	4	2	3	8	-	4	10	6	14	15	-	
75	Jan. to Mar. 1938	22	13	10	3	-	-	21	78	7	2	-	1	2	1	1	1	-	-	-	2	3	3	2	1	
76	Apr. to June 1938	17	9	3	6	-	-	7	47	3	3	1	-	2	-	-	-	1	2	-	3	-	-	2	-	
77	July to Sept 1938	17	9	5	3	-	1	9	42	5	2	1	-	1	-	1	-	1	-	1	1	1	1	2	-	
78	Oct. to Dec. 1938	24	15	9	6	-	-	30	100	10	3	2	1	1	1	-	1	1	-	1	5	-	3	4	1	
	TOTAL YEAR 1938	80	46	27	18	-	1	67	267	25	10	4	2	6	2	2	2	3	2	2	11	4	7	10	2	
79	Jan. to Mar. 1939	20	15	-	-	-	-	17	83	7	1	3	1	-	1	1	3	3	-	-	4	1	5	2	-	
80	Apr. to June 1939	26	17	-	-	-	-	24	79	7	4	1	2	4	2	1	1	-	1	2	5	-	3	5	1	
81	July to Sept 1939	17	9	-	-	-	-	9	57	3	-	2	3	2	-	-	3	-	1	-	1	1	4	2	-	
82	Oct. to Dec. 1939	18	10	-	-	-	-	7	118	7	1	-	2	-	1	1	2	-	-	-	1	-	3	6	-	
	TOTAL YEAR 1939	81	51	-	-	-	-	57	337	24	6	6	8	6	4	3	9	3	2	2	11	2	15	15	1	
	GRAND TOTAL 12 YEARS	1002	561	298	206	-	7	751	3,327	344	86	69	75	50	38	23	43	71	8	33	86	56	128	121	14	

CAUSES OF ACCIDENTS, CASUALTIES, AND NUMBER OF FREIGHT TRAINS BY VARIOUS LENGTHS

	CAUSE	PER CENT. OF TOTAL ACCIDENTS	NUMBER OF ACCIDENTS	PERSONS KILLED	PERSONS INJURED	NUMBER OF FREIGHT TRAINS INVOLVED AS TO VARIOUS LENGTHS IN CARS, EXCLUSIVE OF CABOOSE: 40 AND LESS	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100	OVER 100	TO
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	
I.	NEGLIGENCE OF EMPLOYES	62.2	349	390	2,428	258	53	45	53	31	22	15	22	
II.	DEFECTS IN OR FAILURES OF EQUIPMENT	14.1	79	108	318	24	11	10	6	9	9	6	15	
III.	DEFECTS IN OR IMPROPER MAINTENANCE OF WAY AND STRUCTURES	5.9	33	57	202	17	7	4	2	3	1	1	1	
IV.	MISCELLANEOUS CAUSES	17.8	100	196	379	45	15	10	14	7	6	1	5	
	GRAND TOTAL	100.0	561	751	3,327	344	86	69	75	50	38	23	43	

HANDLING FREIGHT CARS

Defts. Ex. No. 270 (Witness J. J. SULLIVAN)

PRIMARY CAUSE OF ACCIDENT INVESTIGATED								
	NEGLIGENCE OF EMPLOYES							
ALL OTHER CAUSES EXCEPT NEGLIGENCE (22)	CONDUCTORS & BRAKEMEN (23)	ENGINEERS & FIREMEN (24)	JOINT TRAINMEN & ENGINEMEN (25)	TRAIN DISPATCHERS & OPERATORS (26)	ALL OTHER EMPLOYES (27)	JOINT TWO OR MORE OTHER EMPLOYES (28)	NOT DEFINITELY DETERMINED OR QUESTIONABLE (29)	TOTAL ALL CAUSES (30)
3	2	1	4	-	1	-	-	16
4	-	3	1	-	-	2	1	13
3	2	2	1	-	-	-	1	14
2	3	1	6	1	2	-	-	19
12	7	7	12	1	3	2	2	62
1	4	8	7	-	-	2	1	26
-	-	2	-	-	-	-	2	8
3	1	2	3	-	1	-	1	12
6	1	2	5	-	1	2	-	21
10	6	14	15	-	2	4	4	67
2	3	3	2	1	-	2	-	13
3	-	-	2	-	1	-	-	9
1	1	1	2	-	1	1	-	9
5	-	3	4	1	-	-	-	15
11	4	7	10	2	2	3	-	46
4	1	5	2	-	-	-	-	15
5	-	3	5	1	-	-	-	17
1	1	4	2	-	-	-	-	9
1	-	3	6	-	-	-	-	10
11	2	15	15	1	-	-	-	51
96	56	128	121	14	18	12	14	561

NUMBER OF FREIGHT TRAINS INVOLVED AS TO VARIOUS LENGTHS IN CARS, EXCLUSIVE OF CABOOSE									TOTAL			
									70 CARS AND LESS		OVER 70 CARS	
40 AND LESS (5)	41 TO 50 (6)	51 TO 60 (7)	61 TO 70 (8)	71 TO 80 (9)	81 TO 90 (10)	91 TO 100 (11)	OVER 100 (12)	TOTAL (13)	NO. (14)	PER CENT. (15)	NO. (16)	PER CENT. (17)
258	53	45	53	31	22	15	22	499	409	82.0	90	18.0
24	11	10	6	9	9	6	15	90	51	56.7	39	43.3
17	7	4	2	3	1	1	1	36	30	83.3	6	16.7
45	15	10	14	7	6	1	5	103	84	81.6	19	18.4
344	86	69	75	50	38	23	43	728	574	78.8	154	21.2

way and near the end of which barely reached standardization, with the second six years when the standard long-train program was an accomplished fact. The collision rate per million train miles dropped from .50 in the first period to .23 in the second, per million locomotive miles from .34 in the first period to .16 in the second, and the casualty rate correspondingly dropped from .26 per million train miles in the first period to .11 in the second, and from .18 per million locomotive miles to .08 in the second. These decreases were far greater, in percentage, than the decreases in the total number of train miles and locomotive miles from the first six-year period to the second six-year period (Columns c and d, lines 7 and 14, Sheet 1).

(e) COMMISSION'S INVESTIGATION OF TRAIN ACCIDENTS—NATIONAL (R. 3982-3983).

The first paragraph of this finding deals generally with the official investigations by the Bureau of Safety of the Interstate Commerce Commission, authorized by Section 3 of the Federal Accident Reports Acts. Mr. Sullivan presented two exhibits, analyzing the printed results of those investigations of freight-train accidents for the 12-year period, 1928-1939 (Exhibit 270, R. 3310-3335), and of passenger-train accidents for the six-year period, 1934-1939 (Exhibit 271, R. 3336-3348).

(1) Freight-Train Accidents (R. 3982-3983):

This sub-finding is based on Mr. Sullivan's Exhibit 270. This 26-sheet exhibit analyzes those investigations in great detail, so far as they are related to freight trains. For convenient reference we insert opposite this page a reproduction of sheet 2 of that exhibit, at the bottom of which there

is a summary of the exhibit. In addition to the statements made in the sub-finding, it will be seen that collisions accounted for 298 of the 561 accidents involving freight trains which were covered in that exhibit. Sheet 3 of the exhibit reproduces the statute which confers broad authority upon the Commission to investigate railroad accidents.

(2) Passenger-Train Accidents (R. 3983):

The companion exhibit to Exhibit 270 is Exhibit 271 which relates to the Interstate Commerce Commission investigation of passenger-train accidents for the years 1934 to 1939. It is a 13-sheet exhibit, sheet 1 of which we insert opposite this page for convenient reference. That summary sheet shows that 232 accidents involving passenger trains are tabulated and explained in the exhibit. Of that number 96 were due to collisions; and 112 of the total number which, of course, included some of the collisions, were due to negligence of employes. Nothing could show more clearly than Exhibits 270 and 271 that any law that requires a railroad to run more passenger-train miles and more freight-train miles than are necessary to handle its traffic, and consequently to increase the number of employees who may be negligent or forgetful, is distinctly a measure that will promote train and train-service accidents of all classes instead of diminishing them.

(f) ACCIDENT STATISTICS—DEFENDANT'S PACIFIC LINES (R. 3983-3985).

This sub-finding is divided into two sub-divisions which are practically self-explanatory:

TABULATION OF DATA
PUBLISHED IN QUARTERLY SUMMARIES OF ACCIDENT INVESTIGATION REPORTS
INTERSTATE COMMERCE COMMISSION - BUREAU OF SAFETY
IN SO FAR AS IT RELATES TO ACCIDENTS INVOLVING PASSENGER TRAINS
IN THE UNITED STATES

YEARS 1934 TO 1939

I. C. C. BUREAU OF SAFETY QUARTERLY SUMMARY OF ACCIDENT INVESTIGATION REPORTS NO.	PERIOD COVERED	TOTAL NO. OF ACCIDENTS, ALL KINDS OF TRAINS INVESTIGATED	NUMBER OF ACCIDENTS INVESTIGATED INVOLVING PASSENGER TRAINS: TOTAL NUMBER INVOLVING PASSENGER TRAINS	COLLISIONS	DERAILMENTS	MISCL.	PERSONS KILLED: PASSENGERS	EMPLOYES	ALL OTHERS	PERSONS INJURED: PASSENGERS	EMPLOYES	ALL OTHERS	TOTAL NUMBER OF PASSENGER TRAINS INVOLVED AS TO VARIOUS LENGTHS IN CARS: 5 AND LESS	6 TO 8	9 TO 11	12 TO 14	OVER 14	TOTAL	PRIMARY CAUSES OF ACCIDENT INVESTIGATED: DEFECTS IN OR FAILURES OF EQUIPMENT	DEFECTS IN OR IMPROPER MAINTENANCE OF WAY AND STRUCTURES	COLLISIONS WITH VEHICLES AT GRADE CROSSINGS	ALL OTHER CAUSES EXCEPT NEGLIGENCE	NEGLIGENCE OF EMPLOYES: CONDUCTORS AND BRAKEMEN	ENGINEMEN AND FIREMEN	JOINT TRAINMEN AND ENGINEMEN	DISPATCHERS AND OPERATORS	OTHER EMPLOYES	JOINT TWO OR MORE OTHER EMPLOYES	TOTAL NEGLIGENCE	NOT DEFINITELY DETERMINED
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)	(s)	(t)	(u)	(v)	(w)	(x)	(y)	(z)	(aa)	(bb)	(cc)	(dd)	(ee)
59	Jan to Mar 1934	24	12	3	9	-	9	14	4	62	35	10	7	6	1	1	-	15	1	-	-	5	1	-	3	2	-	-	-	5	-
60	Apr to June "	13	5	2	3	-	1	5	-	6	10	1	3	1	-	-	-	6	-	-	-	2	1	1	1	1	-	-	-	3	-
61	July to Sept "	17	11	1	8	-	1	12	8	167	19	18	5	1	4	2	-	12	-	-	-	4	3	1	2	1	-	-	-	4	-
62	Oct to Dec "	21	10	1	7	-	2	16	1	73	20	14	5	1	3	2	-	13	-	1	-	5	-	2	3	-	-	-	-	5	1
	TOTAL YEAR 1934	77	38	11	27	-	13	47	13	310	84	43	22	11	10	5	-	46	1	1	-	16	5	4	9	4	-	-	-	17	1
63	Jan to Mar 1935	16	9	4	4	1	-	5	2	238	49	24	3	4	1	1	1	10	1	-	1	1	1	3	2	-	-	-	6	-
64	Apr to June "	17	5	4	-	1	-	3	14	25	11	18	3	-	2	-	-	5	-	-	1	-	-	3	1	-	-	-	4	-
65	July to Sept "	22	6	2	3	1	6	7	3	76	38	13	3	1	1	-	1	6	-	-	2	1	-	1	1	-	1	-	3	-
66	Oct to Dec "	16	8	1	6	1	-	7	1	16	17	9	1	2	1	-	1	5	-	4	2	1	-	-	1	-	-	-	1	-
	TOTAL YEAR 1935	71	28	11	13	4	6	22	20	375	115	64	12	7	5	1	3	30	1	4	6	3	1	7	5	-	1	-	14	-
67	Jan to Mar 1936	28	12	6	5	1	2	12	11	135	43	23	6	6	1	3	-	16	-	1	2	3	-	4	2	-	-	-	6	-
68	Apr to June "	18	5	2	2	1	3	1	3	222	18	5	4	2	-	1	-	6	-	-	1	1	-	1	1	-	-	-	2	-
69	July to Sept "	28	8	4	3	1	-	10	4	97	31	9	5	2	1	1	-	9	-	-	2	3	-	3	2	-	-	-	5	-
70	Oct to Dec "	27	10	3	5	-	11	11	3	152	29	15	6	4	1	2	-	13	1	1	2	4	-	1	2	-	-	-	5	-
	TOTAL YEAR 1936	101	35	15	15	3	16	34	21	606	121	52	21	14	3	7	-	44	1	2	7	11	-	9	7	-	-	-	18	-
71	Jan to Mar 1937	36	11	2	7	2	-	9	3	110	28	11	5	1	4	1	-	11	1	-	4	3	1	1	1	-	-	-	3	-
72	Apr to June "	18	8	1	5	-	-	5	-	130	22	14	5	1	1	2	-	9	1	-	-	1	1	3	1	-	-	-	5	-
73	July to Sept "	17	6	2	2	-	-	3	-	242	29	1	1	1	1	2	-	7	-	1	-	1	1	1	1	-	-	-	3	-
74	Oct to Dec "	19	12	2	11	1	1	13	16	182	18	51	10	5	4	2	1	22	-	1	4	4	-	1	1	-	-	-	6	-
	TOTAL YEAR 1937	110	44	16	25	3	1	30	19	664	117	77	21	8	12	7	1	49	2	2	8	10	-	6	4	-	-	-	19	-
75	Jan to Mar 1938	22	12	7	5	-	3	14	3	110	29	12	7	4	2	2	-	15	-	-	3	-	-	1	4	2	1	-	1	9	-
76	Apr to June "	17	9	4	4	1	42	10	2	143	36	13	2	2	1	3	1	11	-	1	1	3	-	1	2	-	1	-	4	-
77	July to Sept "	17	9	5	4	-	9	9	2	209	51	14	1	5	1	3	-	12	1	-	1	3	1	-	2	-	1	-	4	-
78	Oct to Dec "	24	11	2	6	2	-	3	3	273	25	9	3	2	1	3	-	14	-	1	2	4	-	2	1	1	-	-	4	-
	TOTAL YEAR 1938	80	41	18	19	3	54	36	10	735	141	48	13	11	5	11	1	52	1	4	7	10	2	4	9	3	2	1	21	-
79	Jan to Mar 1939	20	10	5	4	1	-	9	2	120	20	17	5	1	3	1	-	10	-	1	-	3	1	1	1	-	-	1	6	-
80	Apr to June "	26	12	4	6	2	-	4	1	147	31	10	5	1	2	2	-	12	1	1	-	-	1	3	3	-	-	-	6	-
81	July to Sept "	17	11	5	6	-	10	19	-	492	67	21	5	-	4	1	1	11	-	1	-	1	1	2	3	-	1	-	7	-
82	Oct to Dec "	18	12	4	8	-	1	4	-	120	26	21	1	-	1	-	-	2	-	1	-	1	1	-	4	-	2	1	8	-
	TOTAL YEAR 1939	81	45	20	24	3	11	36	3	879	144	69	16	2	10	4	1	35	1	4	1	5	3	7	11	1	3	2	27	-
	GRAND TOTAL SIX YEARS	520	232	96	120	14	105	217	86	3 789	729	350	110	57	37	37	6	267	7	21	42	49	10	50	40	3	8	3	117	1

SUMMARY OF CAUSES OF ACCIDENTS INVESTIGATED, CASUALTIES, AND NUMBER OF PASSENGER TRAINS OF VARIOUS LENGTHS INVOLVED

	PER CENT OF TOTAL ACCIDENTS	NUMBER OF ACCIDENTS	PERSONS KILLED: PASSENGERS	EMPLOYES	ALL OTHERS	PERSONS INJURED: PASSENGERS	EMPLOYES	ALL OTHERS	TOTAL NO. OF PASSR. TRAINS OF VARIOUS LENGTHS IN CARS: 5 AND LESS	6 TO 8	9 TO 11	12 TO 14	OVER 14	TOTAL	TOTAL NUMBER OF TRAINS: 14 CARS AND LESS NUMBER	14 CARS AND LESS PER CENT	OVER 14 CARS NUMBER	OVER 14 CARS PER CENT
	(ff)	(gg)	(hh)	(ii)	(jj)	(kk)	(ll)	(mm)	(nn)	(oo)	(pp)	(qq)	(rr)	(ss)	(tt)	(uu)	(vv)	(ww)
I. Negligence of employes	68.3	232	44	93	7	2 504	449	162	62	30	31	16	3	142	139	97.9	3	2.1
II. Defects in or failures of equipment	3.0	7	1	-	2	108	10	9	2	2	1	2	-	7	7	100.0	-	-
III. Defects in or improper maintenance of way	9.1	21	3	10	3	384	49	37	9	3	7	4	-	23	23	100.0	-	-
IV. Collisions with vehicles at grade crossings	18.1	42	3	42	67	239	78	66	20	8	10	4	1	43	42	97.7	1	2.3
V. Miscellaneous	21.5	50	54	90	7	554	143	76	19	14	8	11	2	52	50	96.2	2	3.8
GRAND TOTAL	100.0	232	105	217	86	3 789	729	350	110	57	57	37	6	267	261	97.8	6	2.2

BRIEF DESCRIPTION OF ACCIDENTS INVOLVING TRAINS WHICH CONSISTED OF MORE THAN 14 CARS

I. C. C. INVESTIGATION NUMBER

1973 A freight train consisting of 41 cars and a caboose collided with the third car from the engine of a 17 car passenger train which was entering a siding. No fatalities resulted, but injury to 35 passengers and 4 Pullman employes occurred. The accident was caused by the failure of the enginemen of the freight train to control the speed of his train approaching the meeting point.

1993 The engine, its tender, and the first 8 cars of a 16 car passenger train were derailed, caused by a washout due to an unusually heavy local rainstorm. There were no fatalities; 18 passengers, 1 dining car employe, 1 train porter and 3 railroad employes were injured.

2016 The engine and first 2 cars of a 16 car passenger train were derailed when it collided with a motor truck at a grade crossing, caused by the motor truck being driven upon the railroad crossing directly in front of the approaching train. There were no fatalities; 9 passengers, 2 dining car employes, 1 Pullman employe, and the driver of the truck were injured.

2212 A 1 car passenger train collided with the 13th car from the engine of a 24 car milk and passenger train which was passing over a cross-over, caused by the failure properly to control the speed of the 5 car train when passing a grade signal and approaching a cross-over at the end of double track. There were no fatalities; the fireman and the baggageman of the milk train and the conductor and fireman of the 5-car train were injured.

2265 The engine and 5 first cars, which had been detached from a 29 car milk train, derailed one of the milk cars while backing into a siding, caused by the separation of a switch point from the stock rail due to the throw-lever of the switch stand being unlatched. The head brakeman was fatally injured.

2314 A 16 car passenger train collided with the side of a 10 car passenger train at a railroad crossing at grade, caused by failure of the enginemen to control the speed of a train in compliance with interlocking signals. One passenger and one employe were killed, and 16 passengers and 2 dining-car employes were injured.

(1) Employes on Duty—All Classes of Service—Train and Train-Service Accidents (R. 3984):

This sub-finding is based on Exhibit 272 (R. 3349). At pages 1985-1986 of the record, Mr. Sullivan explained the reason for the use of locomotive miles to obtain the casualty rate:

"The Court: Mr. Sullivan, I notice on Exhibit No. 262 that you computed your casualty rates on car miles, train miles, locomotive miles, and man hours, whereas on this exhibit the computation apparently is on locomotive miles?

A. It could have been calculated on the other bases, but as I explained before when you take all classes of employes on duty, it includes classes of services where train miles or car miles are not involved; they are not accumulated. I believe I explained my reason on Exhibit No. 262 for showing all of the various bases, not that they were appropriate in all cases but to give as complete a picture of the national showing as could be reflected. Now, the train miles and car miles and man hours can be calculated for Exhibit No. 272; but as to individual railroads the Interstate Commerce Commission statistics do not make all of the various segregations as they do for the railroads as a whole; so we are limited in our ability to draw off statistics by classes where we only use the accident bulletins themselves. . . .

The Court: Do I understand that the Interstate Commerce Commission uses the locomotive miles as their unit of computing these?

A. Locomotive miles and man hours, those two, but they make frequent reference to train miles and other statistics in comparisons.

Mr. Booth: Q. That is where they are considering all employes?

A. That is true.

Q. Train service and nontrain service?

A. I may explain the reason for not using the man hours among the other bases of measurement for a system showing. There are so many varied factors entering into it that rather discolor the comparisons. Various states have different full-crew laws. A considerable mileage of the Southern Pacific is in California and all of the casualty comparisons, either one state with another or even a system showing is distorted by the provisions of the California law."

The rates of decrease correspond favorably with the comparable national statistics.

(2) Trainmen on Duty—All Classes of Service (R. 3984-3985):

This sub-finding is based on Exhibit 273 (R. 3350), and covers Southern Pacific Company-Pacific Lines. The term "trainmen" there used is shown by the exhibit to include engineers, motormen, firemen and helpers, conductors, brakemen and flagmen engaged in passenger, freight, yard or work service; also train baggagemen, but not hostlers. The sources are the Annual Accident Bulletins of the Interstate Commerce Commission.

There is little to add to the finding. The percentages of decrease shown on lines 21, 22 and 23 of the exhibits are practically the same as for the comparable national statistics. The three bases used are locomotive miles, man hours, and car miles. Comparing the five-year period 1935-1939, with the six-year period 1923-1928, line 23 of

the exhibit shows that on the locomotive-mile basis there was a decrease in total casualties of 25.98 per cent; on the man-hour basis a decrease of 14.56 per cent, and on the car-mile basis of 38.16 per cent. An interesting comparison with those figures is afforded by lines 7 and 20, which show that in the year 1923, 51,136,000 locomotive miles were run in the handling of 875,630,000 car miles, while in 1939 but 45,299,000 locomotive miles were run to handle 1,113,826,000 car miles—this despite the inflationary effect on locomotive miles caused by the enforcement of the Arizona law.

(g) NEVADA AND ARIZONA CASUALTY STATISTICS (R. 3985-3996).

This sub-finding consists of nine subdivisions, all of which relate to the comparisons made by us between the accident and casualty results of train operations in Nevada and in Arizona, insofar as relevant to the issues in the case at bar.

For the purposes of this showing appellant used its own reports to the Interstate Commerce Commission of reportable train and train-service accidents and casualties as the basis of the statistical presentation; the appellee afterwards on rebuttal adopting similar source material. Practically speaking, the exhibits relating to the two states merely carry forward to and including the year 1940, the same statistical showings that were made by appellant, as plaintiff in the *First Arizona Train-Limit Case* and in the *Nevada Train-Limit Case*. If one takes the tables in evidence in this branch of the case and stops with 1929, the date when the trial of the *First Arizona Case* began, or

1935, when the casualty tables in the *Nevada Case* were closed, it will be seen that the twelve years which have elapsed since the first case, and the five since the other, have only served to confirm the conclusions drawn by the respective courts as to the weight and value of the Nevada-Arizona comparisons; the same may be said of the Santa Fe casualty statistics (Finding XII(k), R. 4004-4006), which were also on the same basis in each of the three cases. The reason is that the conclusions to be drawn from the comparisons are not mere matters of opinion, but are ultimate facts, and the only facts deducible from a mass of interrelated probative facts.

The tables dealt with in the nine subdivisions of sub finding (g) cover the eighteen years, 1923-1940, inclusive, in both Nevada and Arizona.

Ordinarily we would preface the discussion of their presentation by referring to the evidence offered in support of comparisons between Nevada and Arizona operations in all respects relevant to the issues in this case.

By reason of the arrangement of the findings that course is unnecessary to be followed in this section of the brief, and we respectfully refer the Court to Findings III(c) (R. 3896-3897), IV(c) (R. 3900-3901), and VII(a)(5) (R. 3914-3915).

(1) Propriety and Significance of the Comparison of Nevada-Arizona Statistics on Defendant's Line (R. 3985-3986):

The similarity of operations, traffic, construction, and all other conditions that might have any bearing on the validity of a comparison between Nevada and Arizona

SOUTHERN PACIFIC COMPANY
(Pacific Lines)

COMPARISON OF CASUALTIES TO

ALL CLASSES OF EMPLOYES ON DUTY.
ALL CLASSES OF SERVICE.

SUSTAINED IN TRAIN AND TRAIN SERVICE ACCIDENTS,
REPORTABLE TO THE INTERSTATE COMMERCE COMMISSION
FOR THE YEARS 1923 TO 1940 INCLUSIVE

SOUTHERN PACIFIC LINES
STATES OF NEVADA AND ARIZONA

Year	TOTAL LOCOMOTIVE MILES (Thousands)		CASUALTIES TO ALL CLASSES OF EMPLOYES ON DUTY				TOTAL Casualties		CASUALTIES PER MILLION LOCOMOTIVE MILES	
			Killed		Injured					
	Nevada	Arizona	Nevada	Arizona	Nevada	Arizona	Nevada	Arizona	Nevada	Arizona
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)
1923	4 777	3 782	2	1	65	63	67	64	14.03	17.45
1924	4 350	3 978	6	2	44	62	50	64	11.49	16.09
1925	4 577	5 729	3	1	40	98	43	99	9.39	17.28
1926	4 320	5 997	2	6	36	98	38	104	8.48	17.34
1927	4 466	6 121	2	2	19	58	21	60	4.70	9.80
1928	4 766	6 172	3	4	30	60	33	64	6.92	10.37
Total 1923-1928	27 236	31 779	18	16	224	441	242	457	Average 8.89	Average 14.38
1929	4 835	6 497	2	1	27	78	29	79	6.00	12.16
1930	4 485	5 666	4	2	20	53	24	55	5.35	9.71
1931	3 546	4 872	1	2	10	43	11	45	3.10	9.24
1932	3 045	3 907	1	2	14	34	15	36	4.93	9.21
1933	2 734	3 383	-	1	11	24	11	25	4.02	7.39
1934	3 020	3 660	-	2	14	29	14	31	4.64	8.47
Total 1929-1934	21 665	27 985	8	10	96	261	104	271	Average 4.80	Average 9.68
1935	3 114	4 249	-	1	8	43	8	44	2.57	10.36
1936	3 673	5 202	1	2	11	44	12	46	3.27	8.84
1937	4 000	5 883	1	1	18	66	19	67	4.75	11.39
1938	3 383	4 888	-	1	16	38	16	39	4.73	7.98
1939	3 654	5 230	* 14	2	* 21	43	* 35	43	9.58	8.22
1940	3 933	5 518	1	0	12	34	13	34	3.31	6.16
Total 1935-40	21 757	30 970	17	7	86	268	103	273	Average 4.73	Average 8.81
Total 18 Years	70 678	90 734	43	33	406	968	449	1 001	Average 6.35	Average 11.03

COMPARISON OF AVERAGE CASUALTY RATES DURING DIFFERENT PERIODS

		Nevada	Arizona
Period 1929-1934 compared with 1923-1928	- Decrease	45.9%	32.7%
Period 1935-1940 compared with 1923-1928	- Decrease	46.7%	38.7%
Period 1935-1940 compared with 1929-1934	- Decrease	1.5%	9.0%
Period 1935-1940 compared with 18 year average	- Decrease	25.5%	20.1%

* Includes 13 killed and 12 injured in derailment of streamliner CITY OF SAN FRANCISCO at Harney, Nevada, August 12, 1939, caused by malicious tampering with the track.

COMPARISON OF MAIN TRACK MILEAGE OPERATED AS OF DECEMBER 31, 1939	(miles)	(miles)
ARIZONA - Main line, California-Arizona line to Arizona-New Mexico line (via Gila and Bowie)	455.92	
Main line, Ballton to Picacho via Phoenix	260.42	
Main line, Tucson to Arizona-New Mexico line via Douglas	141.95	
Total main lines		808.29
Branch lines		464.96
Total		1,273.25
NEVADA - Main line, California-Nevada line to Nevada-Utah line	732.56	
Main line, California-Nevada line to Pereley	67.26	
Total main lines		819.82
Branch lines		353.60
Total		1,173.42

in this inquiry, was shown in detail and at great length. It is summarized in this sub-finding with references to the record and to the preceding Findings III(c), IV(c), and VII(a)(5).

For the general purpose of considering trends and comparing accident and casualty frequencies in Nevada with those in Arizona, the following special table, which is constructed by dividing the freight-train car miles, as shown in Exhibit 279 (R. 3374), by the freight-train miles, shown in the same exhibit, may be helpful in arriving at a conclusion. It appears that in 1923 and 1924 the average length of freight trains in Nevada was less than in Arizona, and that the most marked increase began in 1926.

AVERAGE FREIGHT TRAIN LENGTHS ARRIVED AT BY DIVIDING TOTAL FREIGHT-TRAIN CAR MILES BY TOTAL FREIGHT-TRAIN MILES (Data from Exhibit 279).

	Arizona	Nevada		Arizona	Nevada
1923	56.45	49.51	1932	54.73	73.33
1924	55.42	52.44	1933	55.85	76.73
1925	51.04	56.20	1934	56.84	80.71
1926	50.91	62.41	1935	56.48	77.39
1927	50.41	65.22	1936	54.04	75.01
1928	50.98	64.88	1937	53.40	75.42
1929	52.01	64.94	1938	56.52	79.74
1930	54.98	71.85	1939	55.81	79.44
1931	54.43	73.12	1940	56.28	80.39

(2) All Classes of Employes—All Classes of Service (R. 3986-3988):

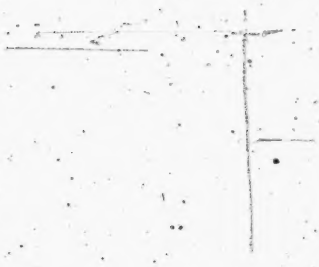
This sub-finding is based on Exhibit 276 (R. 3371), explained by Mr. Sullivan at pages 2000-2002 of the printed record. It presents a comparison of casualties to all classes of employes on duty, and in all classes of service, sustained in train and train-service accidents in Nevada and Arizona for the eighteen years, 1923-1940. Opposite this page we insert a copy of Exhibit 276. The frequency rates

are based on locomotive miles, because the exhibit includes a number of employes whose work cannot be measured in train miles or car miles.

The exhibit shows that the operations in Nevada, considered as a whole, have consistently been much safer, so far as train and train-service accidents were responsible for casualties, than the comparable operations in Arizona. The figures speak eloquently for themselves. While there has been some improvement in Arizona, comparing the first six-year period with the last six-year period, it has not been so great as that in Nevada, where the increase in the average length of freight trains has been marked and continuous. The exhibit includes of course all classes and lengths of trains.

(3) All Classes of Employes—Road Freight Trains (R. 3988-3989):

This sub-finding is based on Exhibit 277 (R. 3372), a copy of which we insert opposite this page. It compares casualties to all classes of employes on duty in road freight-train operation in Nevada, with those in Arizona. Here are shown the freight-train miles and the freight-car miles in each state for each of the 18 years, with the casualties related to that operation, on the million train-mile and 100 million car-mile bases. By this exhibit we begin to see a striking illustration, on the appellant's lines, of the advantages from a safety standpoint of the standard long-train method of operation. In considering this exhibit the Court should also examine the table of average freight train lengths which we submit above in commenting on sub-finding (1).



Superior Court, Pima Co., Arizona
State v. S.P. Co., No. 20087
Defts. Ex. No. ____ (Witness _____)

SOUTHERN PACIFIC COMPANY
(Pacific Lines)

COMPARISON OF CASUALTIES TO

ALL CLASSES OF EMPLOYES ON DUTY, ROAD FREIGHT TRAIN OPERATION

SUSTAINED IN TRAIN AND TRAIN SERVICE ACCIDENTS
REPORTABLE TO THE INTERSTATE COMMERCE COMMISSION
FOR YEARS 1923 TO 1940, INCLUSIVE

SOUTHERN PACIFIC LINES
STATES OF NEVADA AND ARIZONA

	Year	FREIGHT TRAIN MILES (Thousands)		FREIGHT TRAIN CAR MILES (Thousands)		CASUALTIES TO ALL EMPLOYES ON DUTY ROAD FREIGHT TRAIN OPERATION						CASUALTIES PER MILLION TRAIN MILES		CASUALTIES PER 100 MILLION CAR MILES	
						KILLED		INJURED		TOTAL CASUALTIES					
		Nevada	Arizona	Nevada	Arizona	Nevada	Arizona	Nevada	Arizona	Nevada	Arizona	Nevada	Arizona	Nevada	Arizona
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)
(1)	1923	2 259	1 622	111 847	91 565	1	0	48	43	49	43	21.69	26.51	43.81	46.96
(2)	1924	2 035	1 777	106 707	98 490	3	0	27	34	30	34	14.74	19.13	28.11	34.52
(3)	1925	2 262	2 448	127 118	124 954	1	0	34	56	35	56	15.47	22.88	27.53	44.82
(4)	1926	2 077	2 704	129 622	137 660	1	5	18	45	19	50	9.15	18.49	14.66	36.32
(5)	1927	2 146	2 796	139 959	140 957	2	2	14	32	16	34	7.46	12.16	11.43	24.12
(6)	1928	2 418	2 850	156 869	145 287	2	3	23	36	25	39	10.34	13.68	15.94	26.84
(7)	Total 1923-28	13 197	14 197	772 122	738 913	10	10	164	246	174	256	Average 13.18	18.03	Average 22.54	34.65
(8)	1929	2 320	3 083	150 671	160 332	1	0	20	39	21	39	9.05	12.65	13.94	24.32
(9)	1930	2 057	2 574	147 802	141 512	2	2	15	33	17	35	8.26	13.60	11.50	24.73
(10)	1931	1 688	2 205	123 433	120 015	1	0	6	28	7	28	4.15	12.70	5.67	23.33
(11)	1932	1 514	1 849	111 024	101 195	0	1	11	21	11	22	7.27	11.90	9.91	21.74
(12)	1933	1 364	1 632	104 663	91 142	0	1	10	12	10	13	7.33	7.97	9.55	14.26
(13)	1934	1 512	1 800	122 026	102 303	0	1	12	15	12	16	7.94	8.89	9.83	15.64
(14)	Total 1929-34	10 455	13 143	759 619	716 499	4	5	74	148	78	153	Average 7.46	11.64	Average 10.27	21.35
(15)	1935	1 596	2 100	123 508	118 598	0	0	7	22	7	22	4.39	10.48	5.67	18.55
(16)	1936	1 929	2 452	144 689	132 505	0	2	8	20	8	22	4.15	8.97	5.53	16.60
(17)	1937	2 007	2 776	151 385	148 232	1	1	13	34	14	35	6.98	12.61	9.25	23.61
(18)	1938	1 647	2 301	131 331	130 053	0	1	11	19	11	20	6.68	8.69	8.38	15.38
(19)	1939	1 814	2 558	144 106	142 754	1	1	7	19	8	20	4.41	7.82	5.55	14.01
(20)	1940	2 024	2 770	164 482	155 909	1	0	7	18	8	18	3.91	6.50	4.86	11.55
(21)	Total 1935-40	11 039	14 957	859 501	828 051	3	5	53	132	56	137	Average 5.07	9.16	Average 6.52	16.54
(22)	Total 18 Years	34 691	42 297	2 391 242	2 283 463	17	20	291	526	308	546	Average 8.88	12.91	Average 12.88	23.91

		TRAIN MILE BASIS		CAR MILE BASIS	
	COMPARISON OF AVERAGE CASUALTY RATES DURING DIFFERENT PERIODS	Nevada	Arizona	Nevada	Arizona
(23)	Period 1929-1934 compared with 1923-1928 - Decrease	43.4%	35.4%	54.4%	38.4%
(24)	Period 1935-1940 compared with 1923-1928 - Decrease	61.5%	49.2%	71.1%	52.3%
(25)	Period 1935-1940 compared with 1929-1934 - Decrease	32.0%	21.3%	36.5%	22.5%
(26)	Period 1935-1940 compared with 18 year average - Decrease	42.9%	29.0%	49.4%	30.8%

SOUTHERN PACIFIC LINES
STATES OF NEVADA AND ARIZONA

	Year	FREIGHT TRAIN MILES (Thousands)		FREIGHT TRAIN CAR MILES (Thousands)		CASUALTIES TO ALL EMPLOYEES ON DUTY ROAD FREIGHT TRAIN OPERATION						CASUALTIES PER MILLION TRAIN MILES		CASUALTIES PER 100 MILLION CAR MILES	
						KILLED		INJURED		TOTAL CASUALTIES					
	(a)	Nevada (b)	Arizona (c)	Nevada (d)	Arizona (e)	Nevada (f)	Arizona (g)	Nevada (h)	Arizona (i)	Nevada (j)	Arizona (k)	Nevada (l)	Arizona (m)	Nevada (n)	Arizona (o)
(1)	1923	2 259	1 622	111 847	91 565	1	0	48	43	49	43	21.69	26.51	43.81	46.96
(2)	1924	2 035	1 777	106 707	98 490	3	0	27	34	30	34	14.74	19.13	28.11	34.52
(3)	1925	2 262	2 448	127 118	124 954	1	0	34	56	35	56	15.47	22.88	27.53	44.82
(4)	1926	2 077	2 704	129 622	137 660	1	5	18	45	19	50	9.15	18.49	14.66	36.32
(5)	1927	2 146	2 796	139 959	140 957	2	2	14	32	16	34	7.46	12.16	11.43	24.12
(6)	1928	2 418	2 850	156 869	145 287	2	3	23	36	25	39	10.34	13.68	15.94	26.84
(7)	Total 1923-28	13 197	14 197	772 122	738 913	10	10	164	246	174	256	Average 13.18	18.03	Average 22.54	34.65
(8)	1929	2 320	3 083	150 671	160 332	1	0	20	39	21	39	9.05	12.65	13.94	24.32
(9)	1930	2 057	2 574	147 802	143 512	2	2	15	33	17	35	8.26	13.60	11.50	24.73
(10)	1931	1 688	2 205	123 433	120 015	1	0	6	28	7	28	4.15	12.70	5.67	23.33
(11)	1932	1 514	1 849	111 024	101 195	0	1	11	21	11	22	7.27	11.90	9.91	21.74
(12)	1933	1 364	1 632	104 663	91 142	0	1	10	12	10	13	7.33	7.97	9.55	14.26
(13)	1934	1 512	1 800	122 026	102 303	0	1	12	15	12	16	7.94	8.89	9.83	15.64
(14)	Total 1929-34	10 455	13 143	759 619	716 499	4	5	74	148	78	153	Average 7.46	11.64	Average 10.27	21.35
(15)	1935	1 596	2 100	123 508	118 598	0	0	7	22	7	22	4.39	10.48	5.67	18.55
(16)	1936	1 929	2 452	144 689	132 505	0	2	8	20	8	22	4.15	8.97	5.53	16.60
(17)	1937	2 007	2 776	151 385	148 232	1	1	13	34	14	35	6.98	12.61	9.25	23.61
(18)	1938	1 647	2 301	131 351	130 053	0	1	11	19	11	20	6.68	8.69	8.38	15.38
(19)	1939	1 814	2 558	144 106	142 754	1	1	7	19	8	20	4.41	7.82	5.55	14.01
(20)	1940	2 046	2 770	164 482	155 909	1	0	7	18	8	18	3.91	6.50	4.86	11.55
(21)	Total 1935-40	11 039	14 957	859 501	828 051	3	5	53	132	56	137	Average 5.07	9.16	Average 6.52	16.54
(22)	Total 18 Years	34 691	42 297	2 391 242	2 283 463	17	20	294	526	308	546	Average 8.88	12.91	Average 12.88	23.91

		TRAIN MILE BASIS		CAR MILE BASIS	
		Nevada	Arizona	Nevada	Arizona
(23)	COMPARISON OF AVERAGE CASUALTY RATES DURING DIFFERENT PERIODS				
(24)	Period 1929-1934 compared with 1923-1928 - Decrease	43.4%	35.4%	54.4%	38.4%
(25)	Period 1935-1940 compared with 1923-1928 - Decrease	61.5%	49.2%	71.1%	52.3%
(26)	Period 1935-1940 compared with 1929-1934 - Decrease	32.0%	21.3%	36.5%	22.5%
(27)	Period 1935-1940 compared with 18 year average - Decrease	42.9%	29.0%	49.4%	30.8%

COMPARISON OF
MAIN TRACK MILEAGE OPERATED AS OF DECEMBER 31, 1939.

	(miles)	(miles)
ARIZONA - Main line, California-Arizona line to Arizona-New Mexico line (via Gila and Bowie)	455.92	
Main line, Wellton to Picacho via Phoenix	230.42	
Main line, Tucson to Arizona-New Mexico line via Douglas	141.95	
Total main lines		828.29
Branch lines		464.96
Total		1 273.25
NEVADA - Main line, California-Nevada line to Nevada-Utah line	752.56	
Main line, California-Nevada line to Fernley	67.26	
Total main lines		819.82
Branch lines		153.60
Total		973.42

During the six-year period 1923-1928 when, if all of the freight trains operated in those states during that period be considered, there was not a great amount of difference between the average lengths in Arizona and those in Nevada (Nevada, 58.51 cars per train; Arizona, 52.05 cars per train), the casualties on the million train-mile basis are shown to have been 13.18 in Nevada, and 18.03 in Arizona, and on the 100 million car-mile basis 22.54 in Nevada, and 34.65 in Arizona. Then in the second period of six years, 1929-1934, adding together the freight-train car miles in each state for those six years, and dividing the result by the total of the freight-train miles for the six years, we find an average of freight cars per train in Nevada of 72.66 and in Arizona of 54.52. The difference in casualty rates is striking—in Nevada on the train-mile basis 7.46, in Arizona 11.64. On the car-mile basis the comparison is still more significant as it directly bears out our argument that the long-train method of operation is far safer, considering all causes of accidents, than the short train method. On the car-mile basis for the second six-year period, Arizona's average was 21.35, and Nevada's practically one-half of that amount, or 10.27. The comparison between the two states in the third six-year period, 1935-1940, is again of great significance. Obtaining the average length of freight trains during that period by the same statistical method above described, we find for the six years an average length in Nevada of 77.86 cars, and in Arizona of 55.36 cars. On the train-mile basis the casualty rate in Nevada was 5.07 per million train miles, and in Arizona 9.16. On the car-mile basis the superiority of the long-train method of operation

from the safety standpoint is still more apparent, the Nevada rate, per 100 million car miles, being 6.52, and the Arizona rate 16.54. In view of the similarity of operating conditions above referred to, the substantial identity of character and volume of traffic, and all of the other conditions that justify the comparison between Nevada and Arizona, Exhibit 277 standing alone would, we believe, be a sufficient basis for finding that the Arizona law has decreased rather than promoted the safety of freight-train operation.

But we went further and refined the study by producing Exhibit 278 (R. 3373), as a breakdown of Exhibit 277. Exhibit 278 classified the casualties occurring during the 17 years, 1923-1939, by 15 causes, all of which are definitely recognized in the Interstate Commerce Commission classifications of casualties for the purpose of reporting accidents. The year 1940 was not included because when this exhibit was introduced on February 6, 1941 (R. 2002-2003), the 1940 figures were not fully available.

The comparison between Arizona and Nevada with respect to these causes further bears out our contention as to the advantage of long-train operation. Without going into great detail we call attention to the totals. During those 17 years there were, from the 15 causes there tabulated, 528 casualties in Arizona and 300 in Nevada (total car miles for the 17 years, in thousands: in Nevada, 2,226,760; in Arizona, 2,127,554). An analysis of the exhibit will show that as to all of the causes of casualties there shown, which may fairly be said to be related to the number of locomotives or number of train miles operated the Arizona showing is distinctly worse than that of Nevada.

Superior Court, Pima Co., Arizona
State v. S.P. Co. No. 20087
Deft's. Ex. No. 279 (Witness _____)

SOUTHERN PACIFIC COMPANY
(Pacific Lines)

COMPARISON OF CASUALTIES TO

ROAD FREIGHT CONDUCTORS, BRAKEMEN AND FLAGMEN ON DUTY

SUSTAINED IN TRAIN AND TRAIN SERVICE ACCIDENTS
REPORTABLE TO THE INTERSTATE COMMERCE COMMISSION
FOR YEARS 1923 TO 1940, INCLUSIVE

SOUTHERN PACIFIC LINES
STATES OF NEVADA AND ARIZONA

		FREIGHT TRAIN MILES (Thousands)		FREIGHT TRAIN CAR MILES (Thousands)		CASUALTIES TO ROAD FREIGHT CONDUCTORS BRAKEMEN AND FLAGMEN ON DUTY						CASUALTIES PER MILLION TRAIN MILES		CASUALTIES PER 100 MILLION CAR MILES	
						KILLED		INJURED		TOTAL CASUALTIES					
	Year	Nevada	Arizona	Nevada	Arizona	Nevada	Arizona	Nevada	Arizona	Nevada	Arizona	Nevada	Arizona	Nevada	Arizona
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)
(1)	1923	2 259	1 622	111 847	91 565	1	0	43	32	44	32	19.48	19.73	39.34	34.95
(2)	1924	2 035	1 777	106 707	98 490	2	0	22	30	24	30	11.79	16.88	22.49	30.46
(3)	1925	2 262	2 448	127 118	124 954	1	0	31	48	32	48	14.15	19.61	25.17	38.41
(4)	1926	2 077	2 704	129 622	137 660	0	5	14	34	14	39	6.74	14.42	10.80	28.33
(5)	1927	2 146	2 796	139 959	140 957	2	1	13	32	15	33	6.99	11.80	10.72	23.41
(6)	1928	2 418	2 850	156 869	145 287	1	1	21	31	22	32	9.10	11.23	14.02	22.03
(7)	Total 1923-28	13 197	14 197	772 122	738 913	7	7	144	207	151	214	Average 11.44	Average 15.07	Average 19.56	Average 28.96
(8)	1929	2 320	3 083	150 671	160 332	1	0	15	32	16	32	6.90	10.38	10.62	19.96
(9)	1930	2 057	2 574	147 802	141 512	1	1	12	30	13	31	6.32	12.04	8.80	21.91
(10)	1931	1 688	2 205	123 433	120 015	0	0	5	19	5	19	2.96	8.62	4.05	15.83
(11)	1932	1 514	1 849	111 024	101 195	0	0	11	17	11	17	7.27	9.19	9.91	16.80
(12)	1933	1 364	1 632	104 663	91 142	0	1	9	11	9	12	6.60	7.35	8.60	13.17
(13)	1934	1 512	1 800	122 026	102 303	0	1	11	11	11	12	7.28	6.67	9.01	11.73
(14)	Total 1929-34	10 455	13 143	759 619	716 499	2	3	63	120	65	123	Average 6.22	Average 9.36	Average 8.56	Average 17.17
(15)	1935	1 996	2 100	123 508	118 598	0	0	7	17	7	17	4.39	8.10	5.67	14.33
(16)	1936	1 929	2 452	144 689	132 505	0	2	8	13	8	15	4.15	6.12	5.53	11.32
(17)	1937	2 007	2 776	151 385	148 232	1	1	13	31	14	32	6.98	11.53	9.25	21.59
(18)	1938	1 647	2 301	131 331	130 053	0	1	9	17	9	18	5.46	7.82	6.85	13.84
(19)	1939	1 814	2 558	144 106	142 754	1	1	6	14	7	15	3.86	5.86	4.86	10.51
(20)	1940	2 046	2 770	164 482	155 909	0	0	7	15	7	15	3.42	5.42	4.26	9.62
(21)	Total 1935-40	11 039	14 947	849 501	828 051	2	5	50	107	52	112	Average 4.71	Average 7.49	Average 6.09	Average 13.53
(22)	Total 18 Years	34 691	42 297	2 391 242	2 283 463	11	15	257	434	268	449	Average 7.73	Average 10.62	Average 11.21	Average 19.66

		TRAIN MILE BASIS		CAR MILE BASIS	
(23)	COMPARISON OF AVERAGE CASUALTY RATES DURING DIFFERENT PERIODS	Nevada	Arizona	Nevada	Arizona
(24)	Period 1929-1934 compared with 1923-1928 - Decrease	45.6%	37.9%	56.2%	40.7%
(25)	Period 1935-1940 compared with 1923-1928 - Decrease	58.8%	50.3%	69.1%	53.3%
(26)	Period 1935-1940 compared with 1929-1934 - Decrease	24.3%	20.0%	29.3%	21.2%
(27)	Period 1935-1940 compared with 18 year average - Decrease	39.1%	29.5%	46.0%	31.2%

STATES OF NEVADA AND ARIZONA

	Year	FREIGHT TRAIN MILES (Thousands)		FREIGHT TRAIN CAR MILES (Thousands)		CASUALTIES TO ROAD FREIGHT CONDUCTORS BRAKEMEN AND FLAGMEN ON DUTY						CASUALTIES PER MILLION TRAIN MILES		CASUALTIES PER 100 MILLION CAR MILES	
						KILLED		INJURED		TOTAL CASUALTIES					
		Nevada	Arizona	Nevada	Arizona	Nevada	Arizona	Nevada	Arizona	Nevada	Arizona	Nevada	Arizona	Nevada	Arizona
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)
(1)	1923	2 259	1 622	111 847	91 565	1	0	43	32	44	32	19.48	19.73	39.34	34.95
(2)	1924	2 035	1 777	105 707	98 490	2	0	22	30	24	30	11.79	16.88	22.49	30.46
(3)	1925	2 262	2 448	127 118	124 954	1	0	31	48	32	48	14.15	19.61	25.17	38.41
(4)	1926	2 077	2 704	129 622	137 660	0	5	14	34	14	39	6.74	14.42	10.80	28.33
(5)	1927	2 146	2 796	139 959	140 957	2	1	13	32	15	33	6.99	11.80	10.72	23.41
(6)	1928	2 418	2 850	156 869	145 287	1	1	21	31	22	32	9.10	11.23	14.02	22.03
(7)	Total 1923-28	13 197	14 197	772 122	738 913	7	7	144	207	151	214	Average 11.44	Average 15.07	Average 19.56	Average 28.96
(8)	1929	2 320	3 083	150 671	160 332	1	0	15	32	16	32	6.90	10.38	10.62	19.96
(9)	1930	2 057	2 574	147 802	141 512	1	1	12	30	13	31	6.32	12.04	8.80	21.91
(10)	1931	1 688	2 205	123 433	120 015	0	0	5	19	5	19	2.96	8.62	4.05	15.83
(11)	1932	1 514	1 849	111 024	101 195	0	0	11	17	11	17	7.27	9.19	9.91	16 80
(12)	1933	1 364	1 632	104 663	91 142	0	1	9	11	9	12	6.60	7.35	8.60	13.17
(13)	1934	1 512	1 800	122 026	102 303	0	1	11	11	11	12	7.28	6.67	9.01	11.73
(14)	Total 1929-34	10 455	13 143	759 619	716 499	2	3	63	120	65	123	Average 6.22	Average 9.36	Average 8.56	Average 17.17
(15)	1935	1 596	2 100	123 508	118 598	0	0	7	17	7	17	4.39	8.10	5.67	14.33
(16)	1936	1 929	2 452	144 689	132 505	0	2	8	13	8	15	4.15	6.12	5.53	11.32
(17)	1937	2 007	2 776	151 385	148 232	1	1	13	31	14	32	6.98	11.53	9.25	21.59
(18)	1938	1 647	2 301	131 331	130 053	0	1	9	17	9	18	5.46	7.82	6.85	13.84
(19)	1939	1 814	2 558	144 106	142 754	1	1	6	14	7	15	3.86	5.86	4.86	10.51
(20)	1940	2 046	2 770	164 482	155 909	0	0	7	15	7	15	3.42	5.42	4.26	9.62
(21)	Total 1935-40	11 039	14 957	859 501	828 051	2	5	50	107	52	112	Average 4.71	Average 7.49	Average 6.05	Average 13.53
(22)	Total 18 Years	34 691	42 297	2 391 242	2 283 463	11	15	257	434	268	449	Average 7.73	Average 10.62	Average 11.21	Average 19.66

	COMPARISON OF AVERAGE CASUALTY RATES DURING DIFFERENT PERIODS	TRAIN MILE BASIS		CAR MILE BASIS	
		Nevada	Arizona	Nevada	Arizona
(24)	Period 1929-1934 compared with 1923-1928 - Decrease	45.6%	37.9%	56.2%	40.7%
(25)	Period 1935-1940 compared with 1923-1928 - Decrease	58.8%	50.3%	69.1%	53.3%
(26)	Period 1935-1940 compared with 1929-1934 - Decrease	24.3%	20.0%	29.3%	21.2%
(27)	Period 1935-1940 compared with 18 year average - Decrease	39.1%	29.5%	46.6%	31.2%

COMPARISON OF MAIN TRACK MILEAGE OPERATED, AS OF DECEMBER 31, 1939	(miles)	(miles)
ARIZONA - Main line, California-Arizona line to Arizona-New Mexico line (via Gila and Benio)	455.92	
Main line, Wellton to Phoenix via Phoenix	210.42	
Main line, Tucson to Arizona-New Mexico line via Douglas	141.95	
Total main lines		808.29
Branch lines		464.96
Total		1,273.25
NEVADA - Main line, California-Nevada line to Nevada-Utah line	752.56	
Main line, California-Nevada line to Fernley	67.26	
Total main lines		819.82
Branch lines		153.60
Total		973.42

(4) Road Freight Conductors, Brakemen and Flagmen (R. 3989-3990):

This sub-finding is based on Exhibit 279 (R. 3374), a copy of which we insert opposite this page; the exhibit having been prepared by Mr. Sullivan, who explained it, beginning at page 2007 of the printed record:

"The Court: Mr. Sullivan, from these various exhibits it would appear that as compared with the engineers and firemen the conductors, brakemen, and flagmen have a more hazardous occupation?

A. There are more injuries, that is true. Of course, there is an explanation that may be seen by an examination of exhibit No. 278. Engineers and firemen, except in unusual cases, are not required to couple or uncouple locomotives or cars or air hose or steam hose or safety chains. In the performance of their duties, they are always on the moving locomotive, they are not required to get on and off a moving locomotive. They are not required to operate hand brakes, and rarely are required to operate switches unless they are on a light engine, and it is seldom while they are on duty that they are exposed to the other type of injury, being struck or run over by locomotives or cars. As to engineers and firemen, they are exposed to one type of accident that only one member of the train crew is exposed to, and that is collisions, and the collisions and derailments resulting from striking vehicles at grade crossings.

Mr. Strouss: That does not include all collisions, does it, as classified by the Interstate Commerce Commission?

A. Yes, if they were injured, they would be included because this exhibit includes both train and train-service accidents.

Q. When you say 'collisions' that includes collisions between cars that may be switched or collisions of that sort as well as collisions between engines?

A. That is true, but head-on collisions invariably involve one or more locomotives and the engineer and fireman on those locomotives.

Q. Of course the trainman would be exposed if he were on cars that collided in switching?

A. Yes, and the trainmen are exposed to the rear-end collisions."

In addition to the analysis of Exhibit 279 made by the sub-finding, the same observations apply thereto as to Exhibit 277 in comparing one period with another on a train-length basis.

We here print a special table to illustrate that point.

CASUALTIES TO ROAD FREIGHT CONDUCTORS, BRAKEMEN AND FLAGMEN ON DUTY: TRAIN AND TRAIN-SERVICE ACCIDENTS (Data from Exhibit 279).

	Average Cars per Freight Train		Casualties Per Million Train Miles		Casualties Per 100 Million Car Miles	
	Nevada	Arizona	Nevada	Arizona	Nevada	Arizona
1923-1928	58.51	52.05	11.44	15.07	19.56	28.96
1929-1934	72.66	54.52	6.22	9.36	8.56	17.17
1935-1940	77.86	55.36	4.71	7.49	6.05	13.53
18 years	68.93	53.99	7.73	10.62	11.21	19.66

Even if the Arizona law is for the sole benefit of conductors, brakemen, and flagmen, it is apparent that it has entirely failed of its purpose, because it has compelled a method of operation which we show conclusively to be substantially less safe to them than the standard long-train method as defined in the findings.

Superior Court, Pima Co., Arizona
State v. S.P. Co. No. 20087
Defts. Ex. No. 280 (Witness _____)

SOUTHERN PACIFIC COMPANY
(Pacific Lines)

COMPARISON OF CASUALTIES TO

ROAD FREIGHT CONDUCTORS, BRAKEMEN AND FLAGMEN ON DUTY

SUSTAINED IN TRAIN AND TRAIN SERVICE ACCIDENTS

CAUSED FROM SUDDEN STOPPING, STARTING, LURCH AND JERK OF TRAIN

REPORTABLE TO THE INTERSTATE COMMERCE COMMISSION
FOR THE YEARS 1923 TO 1940, INCLUSIVE

SOUTHERN PACIFIC LINES
STATES OF NEVADA AND ARIZONA

	Year	FREIGHT TRAIN MILES (Thousands)		FREIGHT TRAIN CAR MILES (Thousands)		CASUALTIES TO ROAD FREIGHT CONDUCTORS, BRAKEMEN AND FLAGMEN ON DUTY						CASUALTIES PER MILLION TRAIN MILES		CASUALTIES PER 100 MILLION CAR MILES	
						Killed		Injured		Total Casualties					
		Nevada	Arizona	Nevada	Arizona	Nevada	Arizona	Nevada	Arizona	Nevada	Arizona	Nevada	Arizona	Nevada	Arizona
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)
(1)	1923	2 299	1 622	111 847	91 565	0	0	18	7	18	7	7.97	4.32	16.09	7.64
(2)	1924	2 035	1 777	106 707	98 490	0	0	8	5	8	5	3.93	2.81	7.50	5.08
(3)	1925	2 262	2 448	127 118	124 954	0	0	8	7	8	7	3.54	2.86	6.29	5.60
(4)	1926	2 077	2 704	129 628	137 660	0	1	2	10	2	11	.96	4.07	1.54	7.99
(5)	1927	2 146	2 796	139 959	140 957	1	0	6	4	7	4	3.26	1.43	5.00	2.84
(6)	1928	2 418	2 850	156 869	145 287	0	0	14	7	14	7	5.79	2.46	8.92	4.82
(7)	Total 1923-28	13 197	14 197	772 122	738 913	1	1	56	40	57	41	Average 4.32	2.89	Average 7.38	5.55
(8)	1929	2 320	3 083	150 671	160 332	0	0	9	6	9	6	3.88	1.95	5.97	3.74
(9)	1930	2 057	2 574	147 802	141 512	0	0	9	11	9	11	4.38	4.27	6.09	7.77
(10)	1931	1 688	2 205	123 433	120 015	0	0	1	10	1	10	.99	4.54	.81	8.33
(11)	1932	1 514	1 849	111 024	101 195	0	0	6	6	6	6	3.96	3.24	5.40	5.93
(12)	1933	1 364	1 632	104 663	91 142	0	0	4	4	4	4	2.93	2.45	3.82	4.39
(13)	1934	1 512	1 800	122 026	102 303	0	0	5	1	5	1	3.31	.56	4.10	.98
(14)	Total 1929-34	10 455	13 143	759 619	716 499	0	0	34	38	34	38	Average 3.25	2.89	Average 4.48	5.30
(15)	1935	1 596	2 100	123 508	118 598	0	0	4	3	4	3	2.51	1.43	3.24	2.53
(16)	1936	1 929	2 452	144 689	132 505	0	0	6	3	6	3	3.11	1.22	4.15	2.26
(17)	1937	2 007	2 776	151 385	148 232	0	0	4	11	4	11	1.99	3.96	2.64	7.42
(18)	1938	1 647	2 301	131 331	130 053	0	0	6	2	6	2	3.64	.87	4.57	1.54
(19)	1939	1 814	2 555	144 186	142 754	0	0	3	4	3	4	1.65	1.56	2.08	2.80
(20)	1940	2 046	2 770	164 482	135 909	0	0	4	1	4	1	1.96	.36	2.43	.64
(21)	Total 1935-40	11 039	14 957	859 501	828 051	0	0	27	24	27	24	Average 2.45	1.60	Average 3.14	2.90
(22)	Total 18 Years	34 691	42 297	2 391 242	2 283 463	1	1	117	102	118	103	Average 3.40	2.44	Average 4.93	4.51

	COMPARISON OF AVERAGE CASUALTY RATES DURING DIFFERENT PERIODS	TRAIN MILE BASIS		CAR MILE BASIS	
		Nevada	Arizona	Nevada	Arizona
(24)	Period 1929 - 1934 compared with 1923-1928 - Decrease	24.8%	-	39.3%	4.5%
(25)	Period 1935 - 1940 compared with 1923-1928 - Decrease	43.3%	44.6%	57.5%	47.7%
(26)	Period 1935 - 1940 compared with 1929-1934 - Decrease	24.6%	44.6%	29.9%	45.3%
(27)	Period 1935 - 1940 compared with 18 year average - Decrease	27.9%	34.4%	36.3%	35.7%

FOR THE YEARS 1923 TO 1940, INCLUSIVE

SOUTHERN PACIFIC LINES
STATES OF NEVADA AND ARIZONA

	Year	FREIGHT TRAIN MILES (Thousands)		FREIGHT TRAIN CAR MILES (Thousands)		CASUALTIES TO ROAD FREIGHT CONDUCTORS, BRAKEMEN AND FLAGMEN ON DUTY						CASUALTIES PER MILLION TRAIN MILES		CASUALTIES PER 100 MILLION CAR MILES	
						Killed		Injured		Total Casualties					
		Nevada	Arizona	Nevada	Arizona	Nevada	Arizona	Nevada	Arizona	Nevada	Arizona	Nevada	Arizona	Nevada	Arizona
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)
(1)	1923	2 259	1 622	111 847	91 565	0	0	18	7	18	7	7.97	4.32	16.09	7.64
(2)	1924	2 035	1 777	106 707	98 490	0	0	8	5	8	5	3.93	2.81	7.50	5.08
(3)	1925	2 262	2 448	127 118	124 954	0	0	8	7	8	7	3.54	2.86	6.29	5.60
(4)	1926	2 077	2 704	129 622	137 660	0	1	2	10	2	11	.96	4.07	1.54	7.99
(5)	1927	2 146	2 796	139 999	140 957	1	0	6	4	7	4	3.26	1.43	5.00	2.84
(6)	1928	2 418	2 850	156 869	143 287	0	0	14	7	14	7	5.79	2.46	8.92	4.82
(7)	Total 1923-28	13 197	14 197	772 122	738 913	1	1	56	40	57	41	Average 4.32	2.89	Average 7.38	5.55
(8)	1929	2 320	3 083	150 671	160 332	0	0	9	6	9	6	3.88	1.95	5.97	3.74
(9)	1930	2 057	2 574	147 802	141 512	0	0	9	11	9	11	4.38	4.27	6.09	7.77
(10)	1931	1 688	2 205	123 433	120 015	0	0	1	10	1	10	.59	4.54	.81	8.33
(11)	1932	1 514	1 849	111 024	101 195	0	0	6	6	6	6	3.96	3.24	5.40	5.93
(12)	1933	1 364	1 632	104 663	91 142	0	0	4	4	4	4	2.93	2.45	3.82	4.39
(13)	1934	1 512	1 800	122 026	102 303	0	0	5	1	5	1	3.31	.56	4.10	.98
(14)	Total 1929-34	10 455	13 143	759 619	716 499	0	0	34	38	34	38	Average 3.25	2.89	Average 4.48	5.30
(15)	1935	1 596	2 100	123 508	118 598	0	0	4	3	4	3	2.51	1.43	3.24	2.53
(16)	1936	1 929	2 452	144 689	132 505	0	0	6	3	6	3	3.11	1.22	4.15	2.26
(17)	1937	2 007	2 776	151 385	148 232	0	0	4	11	4	11	1.99	3.96	2.64	7.42
(18)	1938	1 647	2 301	131 331	130 053	0	0	6	2	6	2	3.64	.87	4.57	1.54
(19)	1939	1 814	2 556	144 106	142 754	0	0	3	4	3	4	1.65	1.56	2.08	2.80
(20)	1940	2 046	2 770	164 482	155 909	0	0	4	1	4	1	1.96	.36	2.43	.64
(21)	Total 1935-40	11 039	14 957	859 501	828 051	0	0	27	24	27	24	Average 2.45	1.61	Average 3.14	2.90
(22)	Total 18 Years	34 691	42 297	2 391 242	2 283 463	1	1	117	102	118	103	Average 3.40	2.44	Average 4.93	4.51

		TRAIN MILE BASIS		CAR MILE BASIS	
		Nevada	Arizona	Nevada	Arizona
(23)	COMPARISON OF AVERAGE CASUALTY RATES DURING DIFFERENT PERIODS				
(24)	Period 1929 - 1934 compared with 1923-1928 - Decrease	24.8%	-	39.3%	4.7%
(25)	Period 1935 - 1940 compared with 1923-1928 - Decrease	43.3%	44.6%	57.5%	47.7%
(26)	Period 1935 - 1940 compared with 1929-1934 - Decrease	24.6%	44.6%	29.9%	45.3%
(27)	Period 1935 - 1940 compared with 18 year average - Decrease	27.9%	34.4%	36.3%	35.7%

COMPARISON OF MAIN TRACK MILEAGE OPERATED AS OF DECEMBER 31, 1939

	(miles)	(miles)
ARIZONA - Main line, California-Arizona line to Arizona-New Mexico line (via Gila and Bowie)	455.92	
Main line, Wellton to Picacho via Phoenix	210.42	
Main line, Tucson to Arizona-New Mexico line via Douglas	141.95	
Total main lines		808.29
Branch lines		464.96
Total		1,273.25
NEVADA - Main line, California-Nevada line to Nevada-Utah line	752.36	
Main line, California-Nevada line to Fernley	67.26	
Total main lines		819.82
Branch lines		153.60
Total		973.42

(5) Slack-Action Casualties to Trainmen—Nevada-Arizona (R. 3990-3993):

This sub-finding is based on Exhibit 280 (R. 3375), and also Nos. 274 and 275 (R. 3351-3370), which contain the detailed lists of all the reportable casualties to employes on duty, in Nevada and Arizona, sustained in train and train-service accidents 1923-1940, including those shown in Exhibit 280.

We insert opposite this page a copy of Exhibit 280. That exhibit covers the years 1923 to 1940 inclusive, and is confined to the states of Nevada and Arizona and to casualties to road freight conductors, brakemen and flagmen on duty, sustained in train and train-service accidents caused from sudden stopping, starting, lurch and jerk of trains—the so-called "slack-action" accidents—related to both train-mile and car-mile bases.

As pointed out in the sub-finding, the infrequency of occurrence of that type of casualty makes it difficult to make any adequate statistical presentation thereof. During the past six years, 1935-1940, appellant (line 21, Exhibit 280) operated over 11 million train miles in Nevada and very nearly 15 million in Arizona, and handled nearly 860 million freight-car miles in Nevada, and over 828 million in Arizona. Yet in neither of those states was there during that period any death attributable to slack-action, and but 27 reportable injuries in Nevada and 24 in Arizona; slightly more than 3 such casualties in Nevada per hundred million car miles, and slightly less than 3 in Arizona. This cannot fairly be called an exposure to any special hazard under present operating conditions and with the existing motive power and equipment. But as we have shown, the necessity for additional and unneces-

sary starting and stopping of trains is merely an added inducement to slack-action, which is at least as frequent train for train in short-train as in long-train operation.

Further considering this exhibit, it is obvious from what has been said before that the car-mile basis is the fair one to apply to this comparison; and the comparisons on that basis are fully analyzed in the finding.

(6) Caretakers in Cabooses—Nevada-Arizona (R. 3993):

This sub-finding is self-explanatory and is based on Exhibit 288 (R. 382) and the testimony (R. 2027-2029) shown in the annotation. Of course, persons riding on freight trains are equally entitled to protection with those operating them, and the evidence shows that the class of licensees described in the sub-finding has uniformly been safer in Nevada than in Arizona.

(7) Serious Casualties—Nevada-Arizona (R. 3994):

This sub-finding is annotated to the record (Exhibits 274, R. 3351; 275, R. 3364; 281, R. 3376), and requires no further comment.

(8) Casualties Classified—Nevada-Arizona (R. 3994-3995):

This sub-finding is based on the evidence and exhibits shown in the annotations thereto.

No matter what period or class of casualties is viewed in the summary table set forth in the finding, it is evident that the Nevada road freight-train operation has uniformly been substantially safer than that in Arizona. In the past six years, ending with the year 1940 (Exhibit 279, line 21; R. 3374), Nevada road freight trains handled 859,501,000 car miles with 11,039,000 train miles, while Arizona used

14,957,000 train miles to handle 828,051,000 car miles. The 3,918,000 additional and obviously unnecessary train miles used to handle an approximately 4 percent smaller volume of loaded and empty cars can fairly be held to have been responsible for the adverse Arizona showing made in the special table printed in this sub-finding (R. 3994): in Arizona total casualties to road freight conductors, brakemen, and flagmen, 112, in Nevada 52; in Arizona when operating hand brakes, 16, in Nevada 4; in Arizona, getting on or off cars or locomotives 27, in Nevada 9 (this classification is directly related to the stopping and starting of trains as well as to their handling while on the road); miscellaneous train and train-service accidents, 61 in Arizona and 35 in Nevada.

(9) Derailments Reportable as Train Accidents—Nevada-Arizona (R. 3995-3996):

This sub-finding is based on elaborate detailed exhibits (Exhibits 286, R. 3383; 287, R. 3384; 288, R. 3384; 389, R. 3565) which are referred to in the annotation, and a summary of which is printed as a special table in the finding. We refer again to the illustration we gave under finding (8) immediately preceding, in which we compared the train miles and car miles in Nevada and Arizona for the six-year period ending with 1940. In each of the six-year periods, as well as in the 18 years covered by the tables, the comparison is uniformly favorable to Nevada when the number of such derailments is considered on either the train-mile or car-mile basis; so it is as to damage to property, with two slight exceptions which are apparent from the table. And a very significant fact is, as stated in the proposed finding, that of the 70 derailments

in Nevada 35 occurred on long trains and 35 on short trains, with the result that, during the 18 years covered by the tables, 141 of the 176 derailments reported as train accidents in both states occurred to trains of 70 cars or less.

(h) COMPARISON OF SHORT AND LONG-TRAIN PERIODS IN NEVADA WITH EACH OTHER (R. 3996-3997).

This sub-finding is annotated to the record (see Exhibit 282, R. 3377, in particular), and is so explicit and illustrative that it seems to require no comment, except to say that the comparison between the three-year long-train period and the three-year short-train period in Nevada is entirely consistent with all of the other showings of the relative hazard in the two classes of operation. The year 1940 was not available at the time the exhibit was prepared on which this sub-finding is based, but the other exhibits show that its use would not have invalidated the comparison.

(1) Comparison Nevada with Arizona—Three-Year Periods (R. 3997-3998):

This sub-finding includes a special table made up from Exhibits 277 (R. 3372) and 282 (R. 3377), and compares Arizona and Nevada operations for the three years 1923-1925, and the three years 1938-1940, showing the number of casualties on road freight trains to all employes on duty in train and train-service accidents. The special table demonstrates that notwithstanding the improvement in roadbed, signals, equipment, etc., in both states, Nevada, whose average number of cars in freight trains increased from 52.73 to an average of 79.88, had a substantially better safety performance than Arizona, with a corresponding increase from 53.88 to but 56.19.

(i) CASUALTY STATISTICS—DEFENDANT'S LOS ANGELES DIVISION (R. 3999-4000).

It was not our intention to make a detailed showing of casualties on the Los Angeles Division and relate them to any accepted basis for ascertaining frequency rates. There was no more reason for us to select the Los Angeles Division for that purpose than any other of the California divisions, or the operations in Oregon. There is evidence in the record (R. 2166) that the California Full-Crew Law requires substantially more brakemen in freight-train operation than are required in either Nevada or Arizona. For that reason, as explained by Mr. Sullivan (R. 1985), statistics of reportable casualties to train crews would not be on a comparable basis. Each additional employe furnishes additional exposure to whatever hazard there may be incident to the operation of the particular train and additional opportunity for human failure. This is especially true as regards accidents to men in cabooses, where additional brakemen ride while the trains are under way. But in spite of our first intention, the Los Angeles Division came into the case and thus, despite its lack of entire comparability because of the full-crew law provisions just mentioned, there was considerable evidence produced regarding it, which is fully analyzed in the finding.

(j) ACCIDENT AND CASUALTY STATISTICS—DEFENDANT'S LINES IN NEW MEXICO (R. 4001-4004).

Standard long-train practice has never been fully adopted on appellant's lines in New Mexico, primarily because of the controlling extra-territorial influence of the Arizona law on appellant's operations between the eastern

boundary of Arizona and Lordsburg, and also because that compelled operation has a bearing-down effect on the length of freight and passenger trains between Lordsburg and El Paso. The result has been that in respect to the average length of trains, New Mexico operations have been between the standards of Arizona and those of Nevada, but very much closer to the former than to the latter. Results of those operations from a casualty as well as a train-accident standpoint are also between those attained in the two states, and serve in a measure as a check upon and confirmation of the individual statistics in those two states, and the preceding comparisons between them.

(1) Casualties to Persons—Freight-Train Operation (R. 4001-4003):

This sub-finding is annotated to eight exhibits (185, R. 3077; 277, R. 3372; 279, R. 3374; 280, R. 3375; 338, R. 3465; 364, R. 3518; 387, R. 3548-3557; and 397, R. 3578), the significant figures of which are put together in narrative form in the finding. Those exhibits confirm the position of the appellant that its operations can be more safely conducted by the standard long-train method of operation.

(2) Train Accidents—Freight-Train Operation (R. 4003-4004):

This sub-finding is annotated to the exhibits (Nos. 280, R. 3375; 289, R. 3386-3393; 290, R. 3399-3408; 340-349, R. 2680-2682; 388, R. 3558-3567) upon which it is based and completely self-explanatory.

(3) Passenger-Train Accidents and Casualties (R. 4004):

Appellant's passenger-train experience in New Mexico, as shown by Exhibits 362 (R. 3501) and 368 (R. 3527),

summarized in this sub-finding, is in further confirmation of our statement that no plausible theory can be seriously advanced in support of the limitation of passenger trains to the maximum of 14 cars.

(k) SANTA FE CASUALTY STATISTICS—COMPARING SHORT-TRAIN AND LONG-TRAIN OPERATIONS (R. 4004-4006).

This sub-finding is supported by the testimony and exhibits referred to in the annotation thereto. The statistical exhibits summarized in the tables printed in the finding are merely continuations on the same bases as those used by the same railroad in the *First Arizona Train-Limit Case*, and offered by the same witnesses and accepted by the court in the *Nevada Train-Limit Case*. They are strongly confirmatory of the position we have taken with respect to the safety of freight-train operation under the Arizona method, as contrasted with the method used in Nevada and generally throughout the nation. While the case did not call for as elaborate a showing of Santa Fe operations as of those of the appellant, we did, however, lay the foundation for its safety exhibits by detailed testimony of its operating and accounting officials.

We submit that the particular value of the Santa Fe safety showing is twofold. First, it is the only major railroad other than the appellant that operates in Arizona. Second, the trains considered in its safety tables are, so far as the through main-line trains are concerned, the same trains in the long-train as in the short-train territory shown in the table, carrying for the most part the same cars and commodities between California and states east of New Mexico in both east and west-bound move-

ment. The tables cover casualties resulting to road freight trainmen and enginemen on duty from the operation of the through, local and mixed road freight trains, and occurring while on or getting on or off road freight trains, as such casualties were reported to the Interstate Commerce Commission. That group of casualties includes all of the casualties classified under the various code numbers included within the general definition of sudden stop, lurch or jerk of car or train. They also include all or practically all of the accidents that may happen to road freight conductors and brakemen in the additional stopping and starting, signalling, and protection of trains incident to the multiplication of meets and passes by the running of unnecessary trains, additional to those which normally would be required to handle the same volume of traffic. The run of these through trains between Needles, California, and Gallup, New Mexico, is, of course, controlled by the Arizona law; that between Gallup and Belen is somewhat modified as to eastbound trains by the effect of the Arizona law, just as the appellant's operations east of Lordsburg, New Mexico, are modified. The operation between Belen and Clovis is an unrestricted and unmodified standard long-train operation. The average freight-train lengths of 72.69 cars in 1929, and 71.7 in 1939, indicate a very much higher average in through freight trains, as the averages just stated included local and mixed road freight trains. This conclusion is confirmed by the exhibit introduced by witness Weeks of the Santa Fe (Exhibit 138, R. 3007-3009), which for the ten-day typical period selected by him showed representative freight-train lengths in the New Mexico territory east of Gallup as follows: of a total of 263 trains, 113 were of 70 cars or

less; 123 were of 71 to 100 cars; and 27 were of 101 to 125 cars.

We do not suggest, and have not at any time suggested, that the findings of the Special Master or the three-judge court in either the *Nevada Case* or the *First Arizona Case* are binding in this action, even though they were upon the same general issues which are controlling here and based upon the same line of, and in many cases the identical, testimony now in the instant record. We have no more right to suggest compliance with those findings than the appellee has to insist that the *Oklahoma* opinion, based on affidavits submitted without the privilege of cross-examination, is controlling here. But the fact remains, for whatever it may be worth, that in the two similar cases to which this appellant has been a party two Special Masters and six Judges arrived at the same conclusion with respect to the ultimate facts, and did so upon practically the same statistical showings which are merely strengthened by being brought down to include the period which has intervened since those cases were decided. It can be said of the Santa Fe statistics that they clearly illustrate the fact that no matter how the theory of greater safety by long-train operation may be tested statistically, the same result is always obtained and the same conclusion follows.

Truth is always consistent.

(1) CHESAPEAKE & OHIO RAILWAY—CASUALTY STATISTICS (R. 4006-4007):

This sub-finding is based on the exhibits (Nos. 116-118, R. 2976-2978; 121-123, R. 2981-2983) and testimony (R.

867, 872-884) referred to in its footnote. In the body of the sub-findings we have inserted tables giving summaries of the Chesapeake & Ohio exhibits. That railroad was selected because of its outstanding character as an operator of long freight trains, and its highly successful record from a casualty standpoint. The tables are self-explanatory. They stop with 1938, because they were taken from the Annual Statistics and Annual Accident Bulletins of the Interstate Commerce Commission, the latest available at the time the testimony was given having been those for 1938. The testimony of its operating official, Mr. Beale, should leave no doubt of the admissibility of the results of these operations in arriving at findings on the general safety issue. Similar statistics from the Chesapeake & Ohio, brought down to the year 1934, were before the Master and Court in the *Nevada Train Limit Case*.

(m) DECREASE IN CASUALTIES—NEVADA COMPARED WITH ARIZONA (R. 4008-4009).

This sub-finding brings together in a convenient and graphic form the three important exhibits, Nos. 277 (R. 3372), 279 (R. 3374) and 280 (R. 3375), which relate to the reportable casualties in road freight-train operation shown in the three special tables printed in the sub-finding and which summarize those exhibits. These tables are wholly self-explanatory.

(n) CASUALTIES WHILE TRAIN STANDING (R. 4009-4010).

Obviously the occurrence of casualties happening while the train is standing cannot be related to the length of the train although the evidence shows, as abstracted in the finding, that 58 of 73 casualties of that character in Ne-

vada in 18 years occurred on short trains, and, of course, all of those accidents in Arizona were on short trains. It would seem to be evident that any unnecessary increase in the number of trains would have a tendency to increase the number of accidents that occur while trains are standing, particularly in freight service where brakemen are required to get off and on the train for the purpose of flagging. The increase of hazard is in proportion not merely to the additional number of trains but to the increased number of stops made necessary by the running of unnecessary trains.

(o) PASSENGER-TRAIN SAFETY (R. 4010-4013).

The showing of casualties under this subheading is divided between those occurring nationally and those occurring on appellant's lines in Nevada and Arizona. Back of that showing there is the testimony relating to the development of passenger-train locomotives and passenger cars which has been substantially uniform throughout the United States. There is also the testimony of Mr. Parke, Chief Engineer of The Pullman Company, showing the great development in Pullman equipment.

Under sub-finding "XII(e)(2) Passenger Train Accidents" (R. 3983) the discussion covers the Bureau of Safety Investigations of 320 passenger-train accidents during the six-year period 1934-1939, and refers to Exhibit 267 (R. 3305). Over 18 per cent of the passenger-train accidents so investigated were due to collisions with vehicles at grade crossings. The effect of an arbitrary limitation of the length of trains and the consequent increase in the hazard of grade-crossing accidents is discussed hereafter

under Sub-finding (p), "Grade-Crossing Accidents"; but it should be remembered, and the reports of the Bureau of Investigations show, that every collision at a grade crossing carries with it the hazard of the derailment of the locomotive and the following cars, so that whatever lessens the possibility of grade-crossing accidents increases the safety of the employes and passengers on the trains that may collide with the vehicles.

(1) Passenger Casualties—Class I Railroads of the United States (R. 4010):

This sub-finding is based on Exhibit 267 (R. 3305) and needs no amplification.

(2) Passenger Casualties—Nevada and Arizona (R. 4010-4013):

This sub-finding is based on Exhibits 291 and 292 (R. 3409-3421), and analyzes them in some detail. So far as safety is concerned, no form of transportation has made greater progress since 1912 than the passenger train. This is graphically shown by the testimony as well as by the exhibits showing chronologically the development of passenger-car equipment, including Pullman cars. The wooden passenger car is a thing of the past. The rules for reporting accidents are such that necessarily the one-day disability provision results in a great number of reportable accidents that, if they occurred to a pedestrian on the street, would never be reported to the police or find their way into newspaper columns. But they are reported by railroads nevertheless.

Although passenger-train operations, except for the average length of the train, are practically the same in Arizona as they are in Nevada, we find the showing of

casualties adverse to Arizona as related in the finding. Again we say that we are completely at a loss to imagine any even slightly plausible argument in favor of the limitation to fourteen cars as applied to the passenger train of today. If ever a litigant attacking a police power statute has succeeded in proving the "universal negative" to a moral certainty and beyond any reasonable doubt, the appellant has done so, we believe, in the case at bar with respect to the passenger-train limitation. The only individuals that can possibly benefit are those who are unnecessarily employed, and that is not a ground for sustaining an arbitrary regulation of common-carrier transportation.

(p) GRADE-CROSSING ACCIDENTS (R. 4013-4015).

This sub-finding is copiously annotated to the record. It would seem to be perfectly clear that whatever hazard may exist at grade crossings from the running of ten trains of any character across those crossings would be proportionately reduced by the running of but seven trains to handle the same cars and the same traffic. The police power of the State has been and constantly is invoked to compel separation of grades, automatic and manual signals, and other forms of protection to the joint users of grade crossings. But the statute under consideration makes no such attempt and could not be held to do so by indirection. Instead of decreasing hazards by affording fewer opportunities for collisions, it obviously and directly increases those hazards.

(q) FREIGHT-TRAIN DERAILMENTS—NEVADA, ARIZONA AND NEW MEXICO (R. 4015-4017).

Seven exhibits (Nos. 286-290, R. 3383-3408; 388, R. 3558-3564; and 389, R. 3565), bear on this subject. A train derailment is frequently but not always initiated by the derailment of a locomotive, as the detailed statistics show. And, of course, a forced increase in the number of locomotives would, other things being equal, result in a greater number of derailments. The improvements in roadbeds, roadway structures, motive power, signals and equipment have, as shown by the statistics, resulted in a marked decrease in the number of derailments, but notwithstanding those improvements Arizona, as in all other matters pertaining to safety, continues to lag behind. The conclusion is inescapable that this is directly due to the dead hand of the 1912 law.

(r) EMERGENCY APPLICATIONS OF AIR BY ENGINEER (R. 4017).

This sub-finding shows by citations to the evidence (R. 2804, 2817-2818) and exhibits (Nos. 274, 275; R. 3351-3370) that there is nothing whatever in the claim that such emergency applications can be prevented or the number reduced by limiting the cars in a train.

(s) HEAVIER GRADUATING SPRING (R. 4017-4018).

This sub-finding is on a point which was made mention of by the defense and the employe organizations in the *First Arizona Train-Limit Case*. As shown by the evidence, slack-action accidents on either long or short trains, due to weak graduating springs, are no longer to be considered a factor of any consequence in train operation.

(t) ARIZONA LONG-TRAIN OPERATIONS, 1940 (R. 4018-4019).

The operation in Arizona in March and April, 1940, of 62 long passenger trains with 15,587-train miles and 243,749 car miles, and 302 long freight trains with 37,257 train miles and 3,180,278 car miles (average length 85.36 cars) resulted in a striking confirmation of appellant's claim that greater safety of operation could be secured by adopting the standard long-train method of operation in Arizona; this in spite of the fact that primarily because of the shortness of the sidings and passing tracks, full standard long freight-train operation was not possible of accomplishment for the reasons stated by our witnesses.

Sullivan, R. 2053-2055, 2057-2059.
See also *Finding* IX(a) (R. 3947-3948).
Exhibits 246 (R. 3255), 294 (R. 3423), 295 (R. 3424).

We consider that this operation furnished a demonstration of the practicability of safer train operation *in Arizona* if the law is lifted. It added to and confirmed the uniform showing made by the casualty statistics—national, state, and division.

(u) EMPLOYES AFFECTED BY THE TRAIN-LIMIT LAW (R. 4019-4021).

This sub-finding assembles, brings together, and gives record references to the evidence relating to the question of just who are, or may be, affected by enforcement or disregard of the law. The Legislature of 1912 did not see fit to give in the title of the statute, or by way of recital or preamble, any specific reason for its enactment; nor did it describe any condition, the result of which the law was desired to prevent or minimize. But it

is common knowledge that laws of that character have been urged nationally, as well as in the Legislatures of most of the states, by the employe organizations usually referred to as the Train-Service Brotherhoods. Nearly always their primary argument has been that the limitation of the length of trains was necessary to prevent or minimize casualties and other occurrences resulting from slack-action shock.

Counsel for the appellee have adopted this theory; it was forecast in their arguments on objections to testimony and their questions on cross-examination, and formed the principal basis of their presentation of the safety issue to the State Supreme Court. That theory of the law results in the position that the Legislature, under some hidden theory or undeclared intention, may have legislated in behalf of a supposed greater freedom from a minor class of accident for a limited group of employes, regardless of the law's effect on the hazards to all classes of employes who may and occasionally do suffer casualties from the operation of freight and passenger trains, as well as on the hazards to the public, which we have endeavored to describe in the preceding discussion. This sub-finding puts in condensed and narrative form a description of the classes of employes who are adversely affected by the legislation. We have endeavored to show, and we have shown, that the employes for whose protection the law is ostensibly designed are really placed in a more precarious condition by compelled short-train operation, than if appellant were permitted to adopt and practice the standard long-train method of operation.

(v) INCREASE IN ACCIDENT AND CASUALTY HAZARD INHERENT IN INCREASE OF TRAIN UNITS (R. 4021-4022).

The evidence shows beyond any question or doubt that the enforced limitation of train lengths in Arizona has resulted in no decrease of hazard to any group of employes or persons from any recognized cause of reportable casualties; that it has prevented the improvements in roadbed, signals and equipment that have taken place since 1923 from having their full and intended effect and consequently has increased the hazard of train operation instead of lessening it. To illustrate this conclusion we now print a special series of comparisons taken from exhibits with which we have dealt separately under preceding sub-section heads.

COMPARISONS OF IMPROVEMENT PERCENTAGES IN CASUALTY RATES AS SHOWN BY APPELLANT'S STATISTICAL EXHIBITS

Class I Railroads of U. S. A.

Five-year period 1935-1939 compared with six-year period 1923-1928

		PERCENTAGES OF DECREASE BASES	
		Car Mile	Train Mile
Ex.	(Train and Train Service Accidents)		
262	All classes employes on duty	70.33%	66.99%
263	Road Trainmen and Enginemen on duty	69.21%	65.73%
264	Road Freight Trainmen and Enginemen on duty	69.32%	66.15%
265	Road Freight Conductors, Brakemen and Flagmen on duty (all R. R.'s U. S.)	66.21%	62.72%
266	Same employes as Ex. 265, "slack action" casualties	65.29%	61.82%

Nevada-Arizona

Six-year period 1935-1940 compared with six-year period 1923-1928

Ex.		PERCENTAGES OF DECREASE (Car Mile) Nev.	Ariz.	(Train Mile) Nev.	Ariz. (Loco. Miles)
	(Train and Train Service Accidents)				
276	All classes of employes on duty in all classes of service			46.7%	38.7%
277	All classes of employes on duty—Road Freight Train Operation	71.1%	52.3%	61.5%	49.2%
279	Road Freight Conductors, Brakemen, Flagmen on duty	69.1%	53.3%	58.8%	50.3%
280	Same classes as Ex. 279, "slack-action" casualties	57.5%	47.7%	43.3%	44.6%

This concluding sub-finding summarizes and puts in bold relief the additional opportunities for casualties afforded by requiring the appellant to operate additional and unnecessary trains. It concludes with the statement of an ultimate fact which we believe is fully supported by the evidence, and which we desire to repeat in closing our discussion of Chapter XII of the Findings:

> **"Thus the Arizona Train-Limit Law not only bears no reasonable relation to safety but, to the contrary does, and if enforced will continue to, impair and lessen substantially the safety of defendant's train operations in Arizona and the adjacent affected territory."**

XIII.

ANALYSIS OF CERTAIN CONTENTIONS ADVANCED BY PLAINTIFF (R. 4002-4032).

In the interest of a complete disposition of certain contentions suggested in appellee's rebuttal testimony, which

have not been separately treated in preceding findings, appellant as defendant proposed and the trial court adopted a series of findings upon the following emphasized points:

(s) THE CONTENTION THAT, WITH LONG-TRAIN OPERATION, TRAINS WOULD BE DELAYED AT MEETING AND PASSING POINTS BECAUSE OF INADEQUATE SIDING CAPACITIES (R. 4022-4023).

The contention covered by the finding captioned as above was suggested in the cross-examination of appellant's witness Herrell (R. 2203-2204), and also in the direct testimony of witness Fail (R. 2554). The point was not developed to any great extent, apparently for the reason that counsel became convinced that it was wholly untenable.

The fact is that the delay incident to the single or simple "saw-by", the only type referred to in appellee's rebuttal testimony, is comparatively slight, because the operation is not at all complicated. Even these minor delays would, however, be completely eliminated, and, if the siding extensions contemplated by appellant in connection with long-train operation were to be constructed, would not affect operations even in the territory east of Lordsburg where they now occasionally occur. As stated elsewhere (Finding IX-h, R. 3948-3950), appellant did not at the time contemplate any attempt at unrestricted long-train operation with present siding capacities, even if the law's restrictions should be removed in the near future; for the time being, long-train operation would be largely in one direction at one time. The practicability of such limited operation, pending the construction of the longer sidings, has been demonstrated by the experience of April,

1940. Even under the conditions then existing, and in spite of the fact that occasionally saw-by's were involved because some of the trains so operated were obliged to meet opposing trains at sidings where one of the trains exceeded the siding capacity, no serious delays were involved, and the operation as a whole was entirely successful.

(b) THE CONTENTION THAT TRAINS SHOULD BE LIMITED TO 70 CARS IN ORDER THAT THE MEMBERS OF THE CREWS MAY SEE AND INTERPRET SIGNALS MORE READILY (R 4023-4025).

The finding bearing the above title deals with a contention apparently considered to be of some importance by appellee's counsel, inasmuch as it was the subject of extended discussion in appellee's briefs to the courts below. It was apparently advanced in all seriousness, though a careful analysis demonstrates that even if it were true, the fact would be quite unimportant from the safety standpoint.

The facts themselves afford a conclusive answer to appellee's contention. The specific hazards against which the law is directed, according to the claim and contention of our opponents, can arise only while trains are in motion. It has not been claimed, nor is it possible to understand how it could be claimed, that the law prevents or minimizes any train or train-service accidents of the kinds which occur while trains are standing. So far as hand or lantern signals are concerned, there is no authorized signal which might be given while the train is in motion except the stop signal. If the members of the engine crew observe an attempted signal being given from the caboose

they cannot misunderstand; they know that it must be a stop signal. At night, if the signal from the caboose is not seen by the engine crew and the stop must be made, a red fusee may be used, and the stop signal thus conveyed is almost certain to be seen. However, if even that signal is not seen or complied with, then the conductor has both the right and duty to use the emergency valve in the caboose, and thus bring the train to a stop without any hazard at all of slack-action to persons riding in the caboose.

Durnil, R. 2377-2379, 2387-2394, 2404-2406; *Kennedy*, R. 2431-2436; *Cooper*, R. 2446; *Check*, R. 2480-2481; *Stevenson*, R. 2495-2497; *Ash*, R. 2574-2576; 2578-2580, 2599-2603; *Fail*, R. 2618-2622, 2625.

The casualty testimony in this record is very complete, and shows without contradiction that the use of the conductor's valve has not resulted in a casualty of any kind in either Nevada or Arizona, or elsewhere upon a long train, during the last 18 years. There is likewise an affirmative and uncontradicted showing that failure to receive or understand a hand or lantern signal, given while the train was moving, has not resulted in or contributed to a reportable accident or casualty in either Arizona or Nevada during the past 18 years, or in New Mexico or on the Los Angeles Division, California, during the past 11 years. The supposed hazard from failure to see or understand signals on long trains while in motion is purely imaginary.

Exhibits 274 (R. 3351-3363), 275 (R. 3364-3370), 289 (R. 3386-3398), 290 (R. 3399-3408), 386 (R. 3533-3547), 387 (R. 3548-3557).

The challenged law, to the extent that it is considered to be a purported safety regulation, having the purpose of permitting signals on moving trains to be given and received, is clearly unreasonable and arbitrary.

(c) THE CONTENTION THAT MEMBERS OF THE CREWS ON LONG TRAINS ARE IN CONSTANT FEAR OF INJURY, AND ARE THEREBY RENDERED LESS ALERT AND EFFICIENT IN THE PERFORMANCE OF THEIR DUTIES (R. 4025-4026).

Perhaps the most fanciful and illogical of all of the reasons for the law indicated by appellee is the suggestion that compulsory short-train operation eliminates apprehensions, and improves the efficiency, of trainmen who, in cabooses of long trains, are claimed to be in constant fear of injury; that the fixed limitation prevents the slack and slack-action which are alleged to cause such fear.

Whether or not a man suffers fear under any particular set of circumstances is largely determined by his personal reactions. Usually, however, fear is a wholly involuntary emotion, and arises because of circumstances which the individual would like to control but cannot. But the so-called fear testified to by appellee's witnesses is of an unusual and remarkable type: it seems to be easily controlled, and capable of being summoned or dismissed at will. If the contention of appellee is correct, and the testimony of its witnesses is to be accepted, trainmen in cabooses are fearful to the point of inefficiency when a train contains even one car more than 70; but they are largely if not wholly relieved of that fear when that one car is cut off. Fear of that type, manufactured to order for purposes of a particular situation, is too imaginary to be of moment. Indeed, the complete unreality of this

supposed fear is forcefully demonstrated by the fact that the two witnesses who principally made the suggestion have voluntarily elected to serve, for many years, as trainmen and conductors in the long-train territory between Lordsburg and El Paso, where approximately a quarter of all of the freight trains upon which they run are long trains, although each of them has ample seniority to permit him to obtain and hold equivalent positions in train service, in the short-train territory west of Lordsburg. It will be recalled that the entire main-line district between Yuma and El Paso constitutes a single seniority district, and that employes working between El Paso and Lordsburg have equal seniority rights in the remainder of the territory.

Stevenson, R. 2488-2489; *Ash*, R. 2566-2571; *Fail*, R. 2609-2615, 2629-2631.

Even if the fear really exists, there is still no logical basis for contending that it is diminished or eliminated by the restraints of the law. Comparing and combining Nevada and Arizona experiences, the frequency of slack-action casualties, over the past 18 years, has been about as great, if not greater, on short trains as on long trains. Such casualties have not been eliminated by the short-train statute; on the contrary, they have occurred at the rate of about 5 per year, during the last 12 years, upon Arizona short trains operated in full conformity with the law's requirements.

Exhibits 274 (R. 3351-3363), 275 (R. 3364-3370), 280 (R. 3375), 395 (R. 3571).

(d) THE CONTENTION THAT LONG TRAINS CANNOT BE PROPERLY INSPECTED OR SUPERVISED WHILE IN OPERATION, BUT THAT SHORT TRAINS CAN BE, AND THAT LONG-TRAIN OPERATION THEREFORE RESULTS IN GREATER HAZARDS (R. 4026-4029).

The finding bearing the above title relates to a subject which was also discussed at some length in the testimony of appellee's witnesses, and thereafter given considerable emphasis in appellee's presentation to the courts below. In that discussion, as in much of the other testimony relative to the asserted hazards of long-train operation, these witnesses were generally quite ready—even eager—to describe how accidents "might" happen as the result of the supposed impossibility of proper supervision of a moving long-train by the members of the train crew; but were also quite embarrassed and unresponsive when asked to cite specific instances.

The finding states, accurately reflecting the record, that no reportable accident or casualty was referred to, by any of these witnesses, as to which it was claimed or shown that the accident would have been avoided or minimized, if the law's restrictions had been complied with; particularly, that no accident or casualty was referred to, asserted to have been due to a defect in or failure of freight-car equipment on a long train, as to which it was claimed or shown that it was due to the inability of the crew to supervise the operation or that the supervision would have been effective to prevent the accident if the train had consisted of 70 cars or less.

The inspections of the freight cars and freight-car equipment, made by members of the train crews while at inspection or other stops, and equally the supervision

which they undertake from various points of observation along the train, including the engine and caboose, while the train is in motion, are for one primary purpose: to locate existing or possible defects in or failures of the equipment, which may lead to derailments or other accidents, with resulting casualties and damage. If the contentions of appellee's counsel and witnesses were correct, it should follow that in Nevada, where long-train operation predominates, and the other conditions permitting close supervision and inspection of trains are certainly no more favorable than in Arizona (the number of trainmen and other employes making up the crew on a train of over 50 cars is the same as in Arizona), accidents and casualties of this class should be more frequent in the aggregate, and particularly in relation to the traffic moved, than in Arizona; and, in particular, should be much more frequent on the Nevada long trains than on the Arizona short trains. The actual record of derailments due to these causes is the best evidence that long-train operation does not prevent effective supervision. The Nevada accident rates, for reportable derailments due to defects in or failures of freight-car equipment, are much lower than in Arizona; the total number of such derailments is considerably less than in Arizona; and of the Nevada derailments a substantial proportion were on short trains. For the 11-year period 1930-1940, there were only 31 such reportable derailments in Nevada, 11 on short trains; and the rate was 2.11 per 100 million car miles. The corresponding total for Arizona was 42, all on short trains; and the rate was 3.03 per 100 million car miles. Both the actual number and frequency rate of such derailments, were

about 59 per cent greater in Arizona during the six-year period 1935-1940. In New Mexico, where long-train operation takes place, although on a very much smaller scale than in Nevada, the frequency rate of such derailments was lower, during the 11-year period 1930-1940, than in Arizona; moreover, of the 29 derailments which took place in New Mexico, 23 were on short trains, and only 6 on long trains.

Direct comparison between long-train and short-train operation over the same territory, during the first six months of the year 1940, is also available in the record (Exhibit 397, R. 3572). This exhibit relates to operations between Lordsburg and El Paso during the period mentioned. The time returns and delay reports of the conductors who handled the freight trains over that district during that period contained references to 123 defects and occurrences having to do with the operation of freight cars in such freight trains, 88 of which defects and occurrences were detected and discovered on 1900 short freight trains and 35 on 562 long freight trains. Short trains constituted 74.4 per cent of the total; 71.6 per cent of the defects and occurrences were reported on such short trains. Long trains constituted 25.6 per cent of the total; and 28.4 per cent of the defects were reported on such trains. The long trains averaged 94 cars per train; the short trains 63.3 per train. The defects and occurrences thus reported were at the rate of one for each 202,860 car miles on the short trains; and one for each 260,000 car miles on the long trains.

There can be no doubt that inspections at terminals and en route, and the supervision of trains by members

of the train crew while the same are in motion, can be and are as properly and adequately performed on long trains as on short trains; and any claim or contention by appellee that the limitation is necessary for the purpose of permitting more complete inspection is wholly unfounded.

See annotations to *Finding* XIII(d): R. 4029-4303.

(e) THE CONTENTION THAT THE PRESENT TYPE OF AIR-BRAKE EQUIPMENT IS INADEQUATE TO CONTROL THE SPEED OF AND TO STOP LONG TRAINS, BUT IS MORE EFFICIENT AND ADEQUATE UPON SHORT TRAINS (R. 4030-4032).

Although appellee's counsel did not at the trial expressly declare their position to be that the present type of air brakes and their appurtenances are insufficient and inadequate to permit long trains to be adequately controlled and safely stopped, if operated in the affected territory, nevertheless it is impossible to ascribe any other purpose to their repeated questioning of their own witnesses, and as well of certain witnesses called by appellant, all having to do with the operation of air brakes, the methods employed by engineers in handling trains with the air brakes, and particularly their ability to control such trains while in operation. If it were not appellee's contention that the present types of air brakes are inadequate for long-train operation, then all of the testimony referred to would have been immaterial, and without apparent purpose in the case.

Indeed, appellee was virtually compelled either to take this position, or else concede that the law has no safety purpose or relation to safety at all. The briefs filed in the lower courts have sufficiently revealed that its contention is accurately described in the title to the finding,

The analysis of the testimony, set forth in the text of the finding above-captioned, is perhaps the best argument in its support and further extended review is unnecessary. We emphasize, however, that none of the engineers called by appellee was willing to testify that he had ever experienced an accident or casualty through failure to control his train, or that he could not adequately control any train which he might be called upon to handle in the affected territory. The engineer employes of appellant who testified for appellee expressly agreed that the controlling of long trains did not involve any greater *difficulty*, but simply required *more care*. Both of the engineer witnesses called by appellant, each of whom has had at least as much experience in train handling as any witness called by appellee, and possibly much more, testified directly that it is no more difficult to handle and control long trains than short trains; in fact, engineers who handle long trains as a regular practice frequently must take more care than usual, when occasionally called to handle short trains.

One of the best methods of proof is to resort to actual experience and in this case we have not only the experience of years on the system at large, but also the actual experience in the affected territory: the 302 long freight trains operated in Arizona in April, 1940. The finding states, and we here emphasize, that there is no evidence whatever that any of the engineers who handled these trains was unable to control or stop his train, or had any unusual or substantial difficulty in its operation. We are quite sure that if any difficulty or lack of control had developed, appellee's counsel and witnesses would have

made the most of it in evidence. However, as to many of said trains, the record affirmatively shows, from the testimony of the very men who handled or rode upon them, that no difficulty or other notable incident was encountered.

See annotations to *Finding* XII(e): R. 4032.

We do not, in this discussion, overlook the voluminous testimony of appellee's witness Cooper, who testified generally on the subject of air brakes and brake appliances in freight trains. This witness' experience is confined to the Santa Fe, but includes both long-train and short-train operations. His seniority extends into both California and Arizona and he stands sufficiently high on the seniority list in his district to be able to select the position of his choice in freight-train service. At present, and for some time past, he has held a position in long-train territory, where, if any train-control difficulties exist peculiar to long-train operation, he is certain to confront them sooner or later. He voluntarily does not choose to work in Arizona, although if the 70-car limitation removed the difficulties he could have that advantage.

Cooper, R. 2438, 2440.

Clearly there is no foundation whatsoever for any claim that engineers cannot safely control and stop long trains by the use of the present types of the air brakes and their appurtenances, and with no greater difficulty than in the case of short trains.

XIV.

EXTENT OF PENALTIES IMPOSED BY THE LAW (R. 4032).

In response to the issue tendered by paragraph 14 of Part III of the answer (R. 27-28) a specific finding was proposed and adopted showing the extent of the penalties imposed by the law. This finding is based upon computations from Exhibit 214 (R. 3198) and 246 (R. 3255). Exhibit 214 shows that in June and August, 1938, if appellant had disregarded the law entirely and had gone to long-train operation with extended sidings and heavier power, it would have operated some 1,386 long freight trains over the districts between Yuma and Lordsburg via Gila and Tucson, and between Tucson and the New Mexico-Arizona state line near Rodeo (the Douglas line). Expanding this figure to the annual basis, by dividing by 17.89 per cent, we derive a total of approximately 7,800 long freight trains which would thus have been operated during 1938. This figure takes into account an allowance for whatever long-train operation might also have taken place on the Phoenix main line. It is necessarily approximate, but is adequate for the purposes of the finding, which merely states in round figures the total amount of the penalties which the law would impose.

The figure for passenger-train operation is taken from Exhibit 246, which shows that in a period of slightly less than two months in 1940 defendant operated passenger trains of more than 14 cars in Arizona on 62 occasions. Multiplying this figure by six gives a total of approximately 360 long passenger trains per year.

Since the penalties imposed by Section 3 of the law are from $100.00 to $1,000.00 for each offense, a simple com-

putation results in the figures, $816,000 and $8,160,000, which represent the range in the total amount of cumulative penalties for which appellant would be liable, if it were to disregard the Train-Limit Law throughout an entire year.

XV.

THE PERMISSIBLE NUMBER OF CARS IN AN INTERSTATE TRAIN IS A SUBJECT OF NATIONAL AND NOT LOCAL CONCERN (R. 4032-4033).

We desire to preface the discussion of this and the succeeding findings of fact by the suggestion that in the preparation of findings of fact in an action such as the instant case it is somewhat difficult to distinguish between the finding of an ultimate fact and the conclusion of law which follows therefrom. We think it better practice, and such practice has been followed in suits where equitable issues are presented, to follow the course we here adopted and for which there is ample precedent. Moreover, general findings of the character of Findings XV to XX, inclusive, round out the more specific findings that have preceded, and unmistakably express the ultimate conclusions of the Court.

Finding XV is very similar to Finding No. XXIX of the Special Court for Nevada in the *Nevada Train-Limit Case;* and in the respects in which it may be regarded as a conclusion, we believe amply supported by controlling decisions to which we refer in the volume of our brief addressed to the law of the case. Nothing could more clearly illustrate the extra-territorial effect of a law limit-

ing the lengths of interstate trains which are entering or crossing the state in a continuous journey in interstate commerce, or leaving the state on such a journey, than the evidence in the instant case.

XVI.

FINANCIAL BURDEN IMPOSED BY THE LAW A FACTOR IN DETERMINING ITS UNREASONABLENESS (R. 4033-4034).

This finding relates to a consideration of the additional expense that is incurred by appellant in obeying the law, as a factor in passing on the question whether it is unreasonable and arbitrary. As we show in Volume I of this brief, this Court has held that "the matter of expense is an important criterion to be taken into view in determining the reasonableness" of a statute or order made pursuant to the police power. This finding has been carefully phrased so as to confine it within the limits of what we understand to be the weight to be given to expense of compliance, in considering that question.

XVII.

FURTHER ARBITRARY EFFECT OF THE LAW (R. 4034).

This finding should be read in connection with the discussion of Finding XI regarding the various factors that jointly contribute to slack action and slack-action shocks. The finding states an ultimate fact which is fully sustained by the evidence.

XVIII.

IMPAIRMENT OF DEFENDANT'S FACILITIES BY THE LAW (R. 4034).

The probative facts in support of this finding fully state the effect the law has upon the facilities devoted to and used by appellant in interstate commerce, in and adjacent to Arizona.

XIX.

FINANCIAL BURDEN ON INTERSTATE COMMERCE (R. 4034).

This finding is a necessary conclusion from the preceding finding in which the character of the traffic handled by appellant is fully described, and the extent of the annual expense of complying with the law is defined and substantiated. It is a conclusion of fact from these probative facts.

XX.

SUBSTANTIAL ALLEGATIONS SUSTAINED (R. 4034).

A general finding of this kind is customary as a conclusion to special findings of fact in a case where an equitable defense is presented or where a special defense in an action at law is offered, equivalent to an equitable defense.

CONCLUSION.

The findings adopted by the trial court, though quite detailed in certain respects, are no more so than necessary

in a case such as this. They present an accurate condensation and summary of testimony which, as reduced to print for the purposes of the record in this Court, with the exhibits, covers approximately 3545 pages (R. 33-3578).

We have no doubt that this Court, if it deems that the occasion requires it to go behind the trial court's findings and examine the record in detail, will conclude that the trial court has found the facts correctly in the light of the evidence; and will also conclude that the State Supreme Court, to the extent that it has undertaken to reverse the trial court's findings and by implication used that reversal as a basis for its decision, has erred to the prejudice of appellant: because it has in effect made findings, either of fact or mixed fact and law, which are without proper evidentiary support and contrary to the evidence of record.

Upon the facts, no less than upon the law, the decision and judgment of the Supreme Court of Arizona in this cause should be reversed.

Respectfully submitted,

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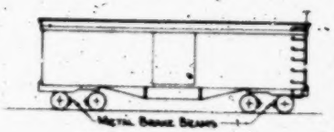
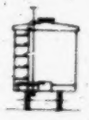
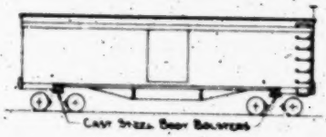
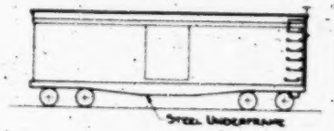
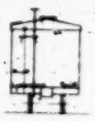
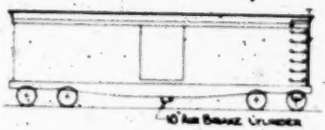
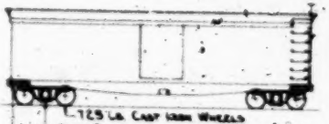
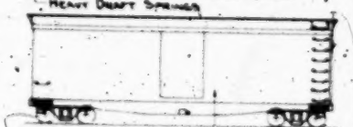
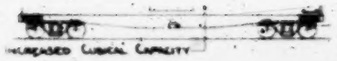
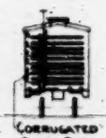
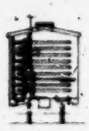
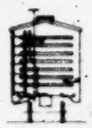
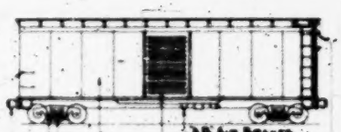
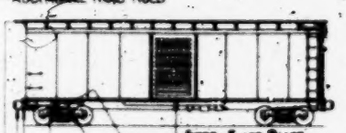
Of Counsel.

Dated November 10, 1944.

SUPERIOR COURT, PIMA CO., ARIZONA
STATE v. SP CO. NO 20087
DEFTS EX NO 12 (WITNESS)

SOUTHERN PACIFIC COMPANY
PACIFIC LINES
CHRONOLOGY OF FREIGHT BOX CARS YEAR 1900 TO 1940
SHOWING DESIGN AND CAPACITY CHARACTERISTICS

Year	Side Elevation A	End Elevation B	New Features C	Carrying Capacity & Weight - Lbs D	Cubical Capacity - Cu Ft E	Cross Sectional Area - Center Sills - Sq Inches F
1900	 Metal Brake Beams		Metal Brake Beams	80 000 50 000	1946	
1901	 Cast Steel Body Bolsters		Cast Steel Body Bolsters	80 000 50 000	2326	
1906	 Steel Underframe		Steel Underframe	80 000 56 000	2448	14
1904	 10" Air Brake Cylinder		10" Air Brake Cylinder	126 000 45 000	2750	18
1909	 725 Lb Cast Iron Wheels Cast Steel Truck Side Frames Heavy Draft Springs		725 Lb Cast Iron Wheels Heavy Draft Springs Cast Steel Truck Side Frames	126 000 45 000	2750	18
1911	 Increased Cubical Capacity		Increased Cubical Capacity	125 000 44 000	3370	18
1913	 K-2 Triple Valve Steel Superstructure Framing		Single Sheathed - Steel Superstructure Framing K-2 Triple Valve	127 000 42 000	3358	25
1916	 Friction Draft Gears		Friction Draft Gears	127 000 42 000	3358	26
2						

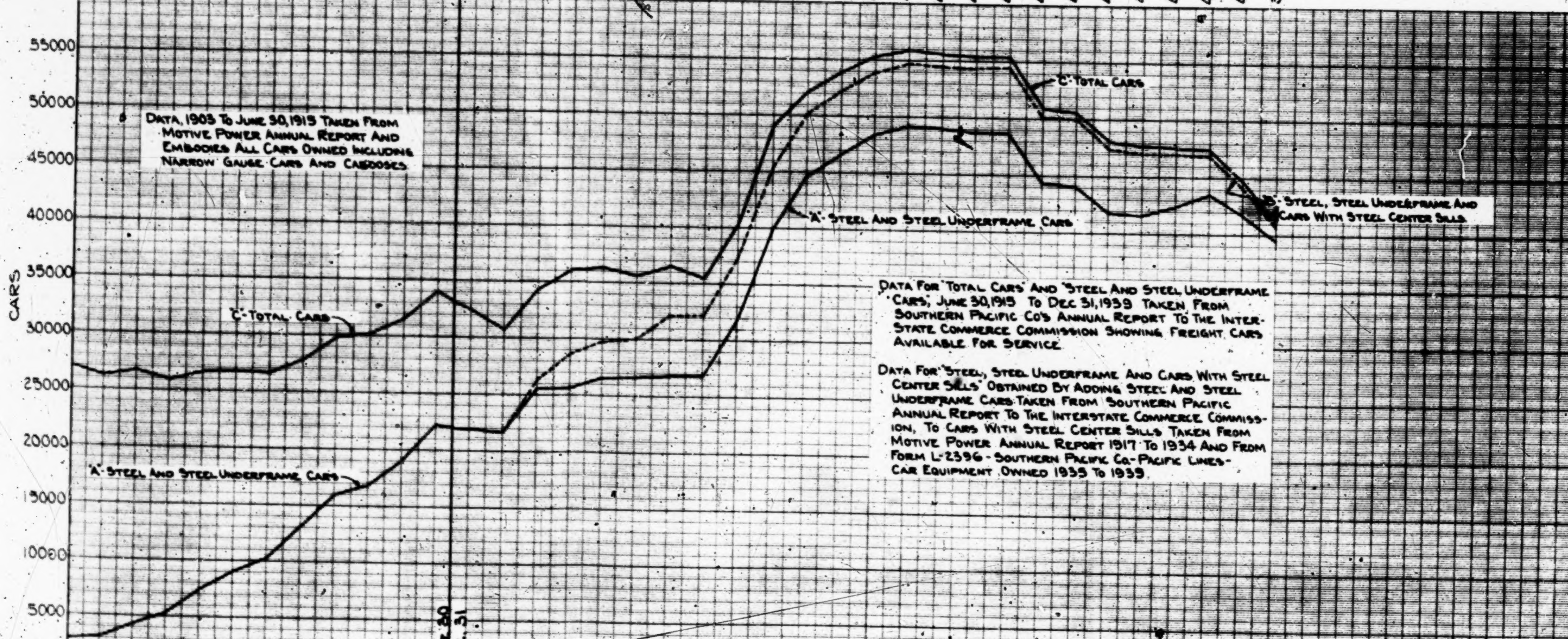
	 INCREASED CUBICAL CAPACITY					
1913	 K-2 TRIPLE VALVE STEEL SUPERSTRUCTURE FRAMING		SINGLE SHEATHED - STEEL SUPERSTRUCTURE FRAMING K-2 TRIPLE VALVE	127 000	42 000	3358	23
1916	 FRICTION DRAFT GEARS		FRICTION DRAFT GEARS	127 000	42 000	3358	26
1919	 CAST STEEL COUPLER YOKES TYPE 'D' COUPLERS	 CORRUGATED STEEL ENDS	TYPE 'D' COUPLERS CAST STEEL COUPLER YOKES CORRUGATED STEEL ENDS	125 000	46 000	3100	26
1924	 STEEL ROOF 750 LB CAST IRON WHEELS		750 LB CAST IRON WHEELS STEEL ROOF	126 000	45 000	3435	26
1925	 HEAVY GRADUATING SPRINGS AUXILIARY HAND BRAKE LEVER		HEAVY GRADUATING SPRINGS AUXILIARY HAND BRAKE LEVER	125 000	44 000	3158	29
1927	 750 LB CAST IRON SINGLE PLATE WHEELS		750 LB CAST IRON SINGLE PLATE WHEELS	125 000	44 000	3138	29
1936 1937	 AB AIR BRAKES STEEL SIDE DOORS ALL STEEL, WOOD LINED POWER HAND BRAKE SNUBBER SPRINGS No 15 BRAKE BEAM, 1936 - No 3 BRAKE BEAM, 1937 TYPE 'E' COUPLERS ADDITIONAL HAND HOLD	 BOTTOM ROD SUPPORTS BRAKE BEAM SAFETY GUARDS	ALL STEEL, WOOD LINED STEEL SIDE DOORS ADDITIONAL HAND HOLDS POWER HAND BRAKE 'AB' AIR BRAKES TYPE 'E' COUPLERS SNUBBER SPRINGS No 15 BRAKE BEAM, 1936 No 3 BRAKE BEAM, 1937 BRAKE BEAM SAFETY GUARDS BOTTOM ROD SUPPORTS	124 000	45 000	3712	213
1940	 STEEL FLOOR PLATE BRAKE PIPE ANCHORS BRAKE HANGER WEARING PLATES WINE BRAKE BALANCER COUPLER CENTERING DEVICE SWIVEL SHANK COUPLER METAL RUNNING BOARD	 W-SECTION CORNER POSTS METAL BRAKE STEP	SWIVEL SHANK COUPLERS COUPLER CENTERING DEVICE METAL RUNNING BOARDS METAL BRAKE STEP W-SECTION CORNER POSTS STEEL FLOOR PLATE WINE BRAKE BALANCER BRAKE HANGER WEARING PLATES BRAKE PIPE ANCHORS	124 000	45 000	3712	213

Southern Pacific Co. Pacific Lines
Comparison Of Freight Cars
All Steel, Steel Underframe And Of Other Construction
Years 1903 To 1939

Superior Court, Pima Co., Arizona
State v. S.P. Co. No. 20087
Defts. Ex. No. 3 (Witness ______)

Number of Cars

A	B	C
2891		26975
3088		26264
4330		26743
5289		25913
7380		26621
9045		26784
10203		26578
13093		27828
15871		29853
16842		30161
18975		31492
22222		34049
21969		33126
21909		32475
21621		30704
25478	26294	34337
25659	28581	35985
26520	29662	36326
26632	29910	35589
26822	32160	36547
26814	32179	35464
31771	37327	40268
39798	45422	49118
44570	50183	52155
46559	52164	53855
48361	53948	55335
49156	54730	55968
48965	54506	55599
48689	54454	55446
48730	54486	55455
44403	50140	50923
44083	49814	50594
41814	47406	48122
41560	47017	47696
42393	47018	47658
43471	46889	47481
41746	44127	44709
39490	40742	41299



ALL STEEL, STEEL UNDERFRAME AND OF OTHER CONSTRUCTION
YEARS 1903 TO 1939

SUPERIOR COURT, PIMA CO., ARIZONA
STATE V. S.P. CO. NO. 20087
DEFTS. EX. NO. 3 (WITNESS _____)

	A	B	C
1903	2891		26575
1904	3088		26264
1905	4330		26743
1906	5289		25913
1907	7380		26621
1908	9045		26784
1909	10203		26578
1910	13093		27828
1911	15871		29853
1912	16842		30161
1913	18975		31492
1914	22282		34049
1915 June 30	21969		33126
1915 Dec. 31	21909		32475
1916	21621		30704
1917	25478	26294	34337
1918	25659	28581	35985
1919	26520	29662	36326
1920	26632	29910	35589
1921	26822	32160	36547
1922	26814	32179	35464
1923	31771	37327	40268
1924	39798	45422	49118
1925	44570	50183	52155
1926	46559	52164	53855
1927	48361	53948	55335
1928	49156	54730	55968
1929	48965	54506	55599
1930	48688	54454	55446
1931	48730	54486	55455
1932	44403	50140	50923
1933	44083	49814	50594
1934	41814	47406	48122
1935	41560	47017	47696
1936	42393	47018	47658
1937	43471	46889	47457
1938	41746	44127	44709
1939	39490	40742	41253

NUMBER OF CARS

55000
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0

DATA, 1903 TO JUNE 30, 1915 TAKEN FROM MOTIVE POWER ANNUAL REPORT AND EMBODIES ALL CARS OWNED INCLUDING NARROW GAUGE CARS AND CABOOSES

C- TOTAL CARS

A- STEEL AND STEEL UNDERFRAME CARS

B- STEEL, STEEL UNDERFRAME AND CARS WITH STEEL CENTER SILLS

DATA FOR 'TOTAL CARS' AND 'STEEL AND STEEL UNDERFRAME CARS', JUNE 30, 1915 TO DEC 31, 1939 TAKEN FROM SOUTHERN PACIFIC CO'S ANNUAL REPORT TO THE INTERSTATE COMMERCE COMMISSION SHOWING FREIGHT CARS AVAILABLE FOR SERVICE.

DATA FOR 'STEEL, STEEL UNDERFRAME AND CARS WITH STEEL CENTER SILLS' OBTAINED BY ADDING STEEL AND STEEL UNDERFRAME CARS TAKEN FROM SOUTHERN PACIFIC ANNUAL REPORT TO THE INTERSTATE COMMERCE COMMISSION, TO CARS WITH STEEL CENTER SILLS TAKEN FROM MOTIVE POWER ANNUAL REPORT 1917 TO 1934 AND FROM FORM L-2396 - SOUTHERN PACIFIC CO.-PACIFIC LINES- CAR EQUIPMENT OWNED 1935 TO 1939.

1903 1904 1905 1906 1907 1908 1909 1910 1911 1912 1913 1914 1915 1915 1916 1917 1918 1919 1920 1921 1922 1923 1924 1925 1926 1927 1928 1929 1930 1931 1932 1933 1934 1935 1936 1937 1938 1939

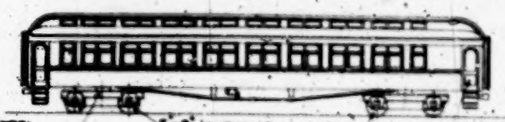
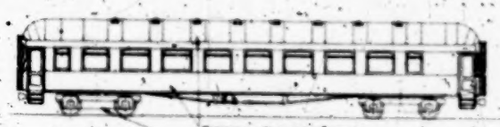
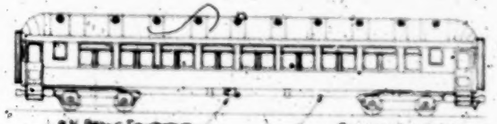
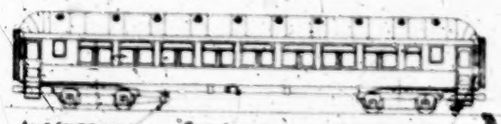
JUNE 30 DEC. 31

YEARS

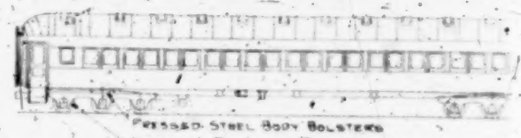
SOUTHERN PACIFIC COMPANY

PACIFIC LINES

CHRONOLOGY OF PASSENGER COACH AND CHAIR CAR YEAR 1900 TO 1940 SHOWING DESIGN AND IMPROVEMENTS.

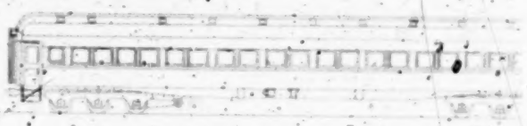
Side Elevation	Year	New Features	Length Over Platforms Coupled	Seating Capacity	Average Weight Lbs
 Cast Steel Body Bolsters; 5"x9" Journals 36" Solid Steel Wheels; Vestibule	1900	Length Increased Seating Capacity Increased Vestibules Air Signal Steam Heat Braking Ratio Increased To 80%	67'-8½"	70	89100
	1901	Gas Lights			
	1902	5"x9" Journals 36" Solid Steel Wheels			
	1903	Trussed Steel Brake Beams			
	1905	Cast Steel Body Bolsters Braking Ratio Increased To 90%			
 Steel Construction Steel Trucks	1906	First Steel Car Built In America Was Constructed In SP Coa. Shops At Sacramento Calif. All Steel Construction Except Inside Finish Which Is Wood Steel Trucks	67'-8½"	70	107000
 Friction Draft Gear All Steel Construction Including Inside Finish	1909	All Steel Construction Including Inside Finish Friction Draft Gear Vapor Steam Heat 2 Steam Train Lines	67'-8½"	72	85000
 L&N Brake Equipment; 15"40# I Beams; Sharon Coupler	1913	Size Of Center Sills Increased From 10"-25# I Beams To 15"-50# I Beams Sharon Couplers Applied In Place Of Janney Couplers L and N Brake Equipment - Type L Triple Valve and Type N Brake Cylinder Size Of Brake Cylinder Increased From 14"x12" To 16"x12" Comb Gas And Electric Lighting	67'-8½"	72	104000
 Axle Generator; End Construction Strengthened	1914	End Construction Strengthened Straight Electric Lighting Axle Generator	68'-3½"	72	107000

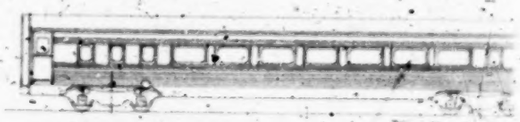
Side Elevation



Pressed Steel Body Bolsters
Integral Pedestal Type Trucks

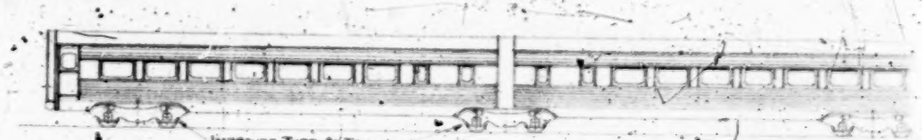
5½"x10" Journals





Outer Sash Tightly Sealed; Truck Mounted Brake Cylinders

SINGLE UNIT



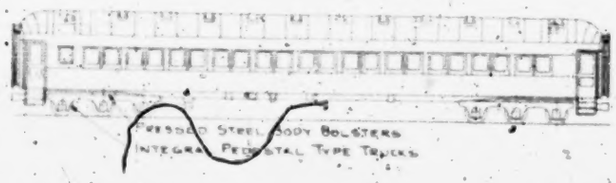
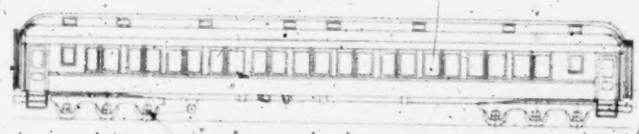
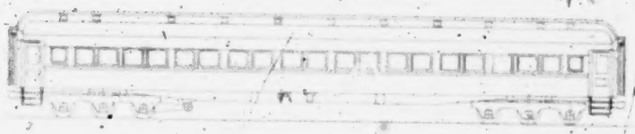
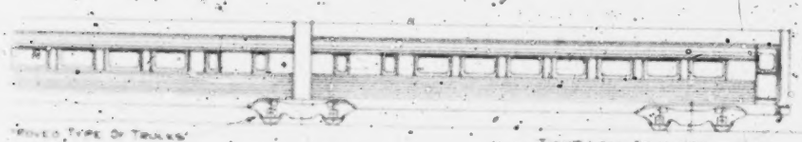
Improved Type 3" Trucks; Tight Lock Couplers And Improved Draft Gear

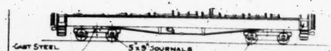
ARTICULATED UNIT

C COMPANY

D CHAIR CAR YEAR 1900 TO 1940
IMPROVEMENTS

SUPERIOR COURT, PIMA CO., ARIZONA
STATE v. S.P.CO. NO 20087
DEFTS. EX NO. 4 (WITNESS LERICHE)

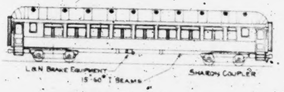
Side Elevation	Year	New Features	Length Over Platforms Coupled	Seating Capacity	Average Weight Lbs
 Pressed Steel Body Bolsters Integral Pedestal Type Trucks	1927	Pressed Steel Body Bolsters Integral Pedestal Type Trucks Locking Center Pins Thermostatic Heat Control Double Deck Spring Seats	80-5½"	90	140500
 5½" x 10" Journals	1928	Mens and Womens Wash Rooms Separate from Toilet Porcelain Wash Basins 5½" x 10" Journals 2 + 2 End Train Line Valves	82-2⅜"	88	150800
	1929	Mens and Womens Lounge Double Pan Hoppers	82-5½"	Body of Car 56 Womens Lounge 4 Mens Smoking Room 4 Total 64	165300
 Outer Sash Tightly Sealed Truck Mounted Brake Cylinders Single Unit	1937	Streamlined Construction; Material- High Tensile and Stainless Steels Air Conditioned Outer Sash Tightly Sealed Tight Lock Couplers Improved Draft Gear Pressure Water System Indirect Lighting Seat Lights Individually Controlled Radio Rotating-Reclining Chairs with Sponge Rubber Seats Aluminum Floor Plates, Cork Flooring, Inlaid Linoleum Floor Covering Insulated Against Noise Compartments for Hand Luggage Electro Pneumatic High Speed Brake Equipment Improved Type of Trucks Provides Easier Riding Spring Pad Lubricators Journals Truck Mounted Brake Cylinders Steam Train Line Connection of 2" Flexible Metallic Conduit	79-2"	Body of Car 48 Womens Lounge 2 Mens Smoking Room 6 Total 56	104500
 Roller Type of Trucks Articulated Unit Tight Lock Couplers and Improved Draft Gear			132-2"	Body of Car 100 Womens Lounge 4 Mens Smoking Room 5 Total 109	170800



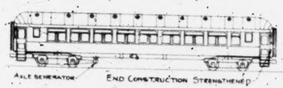
1901	GAS LIGHTS	67'-8½"	70	89100
1902	5 x 9 JOURNALS 36 SOLID STEEL WHEELS			
1903	TRUSSED STEEL BRAKE BEAMS			
1905	CAST STEEL BODY BOLSTERS BRAKING RATIO INCREASED TO 90%			

1908	FIRST STEEL CAR BUILT IN AMERICA WAS CONSTRUCTED IN SP CO'S SHOPS AT SACRAMENTO, CALIF. ALL STEEL CONSTRUCTION EXCEPT INSIDE FINISH WHICH IS WOOD STEEL TRUCKS	67'-8½"	70	107000

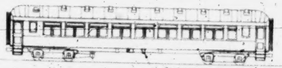
1909	ALL STEEL CONSTRUCTION INCLUDING INSIDE FINISH. FRICTION DRAFT GEAR. VAPOR STEAM HEAT. 2 STEAM TRAIN LINE	67'-8½"	72	85000



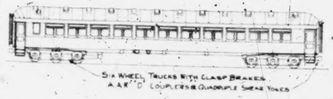
1913	SIZE OF BELTER SILLS INCREASED FROM 15"x 5" I BEAMS TO 15"x6" I BEAMS. SHARON COUPLERS APPLIED IN PLACE OF JANNEY COUPLERS. L-N-N. BRAKE EQUIPMENT - TYPE L TRIPLE VALVE AND TYPE N BRAKE CYLINDERS. SIZE OF BRAKE CYLINDER INCREASED FROM 14"x12" TO 16"x12". COMB. GAS AND ELECTRIC LIGHTING.	67'-8½"	72	104000



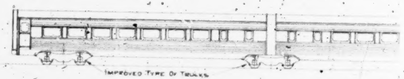
1914	END CONSTRUCTION STRENGTHENED. SEATING CAPACITY INCREASED. ELECTRIC LIGHTING AXLE GENERATOR	68'-6½"	72	107000

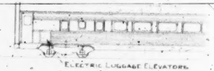


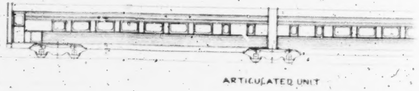
1921	IMPROVED BRAKE EQUIPMENT U-2 UNIVERSAL VALVE. FLUSH HOPPERS. ELECTRIC CEILING FANS	68'-6½"	72	107800

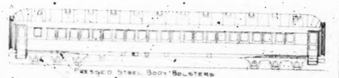


1925	LENGTH INCREASED. SEATING CAPACITY INCREASED. SIX WHEEL TRUCKS WITH CLASP BRAKE. A.A.R. 'D' COUPLER & QUADRUPLE SWEAR YOKES	80'-5½"	96	138600



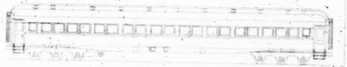






1927	PRESSED STEEL BODY BOLSTERS. INTEGRAL PEDESTAL TYPE TRUCKS. LOCATING CENTER PINS. THERMOSTATIC HEAT CONTROL. DOUBLE DECK SPRING SEATS	80'-5½"	80	140300

1928	MENS AND WOMENS WASH ROOMS SEPARATE FROM TOILET. PORCELAIN WASH BASINS. 5½ x 10" JOURNALS. 2-2½" END TRAIN LINE VALVES.	82'-7⅛"	88	150300



1929	MENS AND WOMENS LOUNGE. DOUBLE PAN HOPPERS.	82'-5½"	BODY OF CAR 56 WOMENS LOUNGE 4 MENS SMOKING ROOM 6 TOTAL 66		165300

1937	STREAMLINED CONSTRUCTION. MATERIAL HIGH TENSILE AND STAINLESS STEELS. AIR CONDITIONED. OUTER SASH TIGHTLY SEALED. TIGHT LOCK COUPLERS. IMPROVED DRAFT GEAR. PRESSURE WATER SYSTEM. INDIRECT LIGHTING. SEAT LIGHTS INDIVIDUALLY CONTROLLED. RADIO. ROTATING RECLINING CHAIRS WITH SPONGE RUBBER SEATS. ALUMINUM FLOOR PLATES CORK FLOORING INLAID LINOLEUM FLOOR COVERING. INSULATED AGAINST NOISE. COMPARTMENTS FOR HAND LUGGAGE. ELECTRO PNEUMATIC HIGH SPEED BRAKE EQUIPMENT. IMPROVED TYPE OF TRUCKS PROVIDED. ROLLER BEARINGS. SPRING AND LUBRICATORS JOURNALS. TRUCK MOUNTED BRAKE CYLINDERS. STEAM TRAIN LINE CONNECTION OF 3" FLEXIBLE METALLIC CONDUIT.	79'-2"	BODY OF CAR 48 WOMENS LOUNGE 2 MENS SMOKING ROOM 4 TOTAL 54		194500

		132'-2"	BODY OF CAR 100 WOMENS LOUNGE 4 MENS SMOKING ROOM 4 TOTAL 108		170800

1939	FLUORESCENT LIGHTING. ELECTRIC LUGGAGE ELEVATORS. CENTER SILLS AND END FRAMING MEMBERS MADE OF SPECIAL CENTER SILL STEEL AND DESIGNED TO MEET A.A.R. COMMITTEE RECOMMENDATIONS. 36" DIAMETER WHEELS. INLAID RUBBER FLOOR COVERING. PUBLIC ADDRESS SYSTEM.	81'-0"	BODY OF CAR 44 WOMENS LOUNGE 2 MENS SMOKING ROOM 4 TOTAL 50		117800

		134'-0"	BODY OF CAR 92 WOMENS LOUNGE 2 MENS SMOKING ROOM 4 TOTAL 98		194500

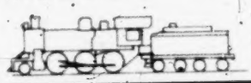
SOUTHERN PACIFIC COMPANY
PACIFIC LINES

CHRONOLOGY OF FREIGHT LOCOMOTIVES PACIFIC LINES
YEARS 1899 TO 1940
SHOWING IMPROVED DESIGN AND INCREASED TRACTIVE EFFORT

SUPERIOR COURT. PIMA CO. ARIZO
STATE v. S.P.CO. NO 20087
DEFTS EX NO. 5 (WITNESS

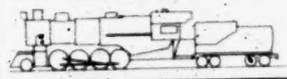
TYPE — WHEEL ARRANGEMENT (WHYTE SYSTEM)

MOGUL 2-6-0



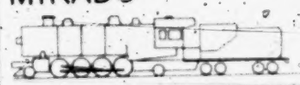
28,710 LBS

CONSOLIDATION 2-8-0



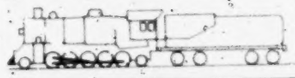
43,300 LBS

MIKADO 2-8-2



51,080 LBS

2-10-2 SMALL 2-10-2



65,300 LBS

2-10-2 LARGE* 2-10-2

75,150 LBS

SOUTHERN PACIFIC* 4-10-2

84,200 LBS

ARTICULATED CONSOLIDATION 4-8-8-2

116900 LBS

ARTICULATED CONSOLIDATION 4-8-8-2 AND 2-8-8-4

124,300 LBS

TYPE	CLASS	YEAR PUT IN SERVICE	NUMBER PURCHASED	AVERAGE PRICE EACH	TRACTIVE EFFORT LBS	WT. ON DRIVERS LBS	BOILER PRESSURE LBS
MOGUL	M-4	1899-1901	103	$14,000	28,710	126,000	190
CONSOLIDATION	C-9,10	1905-1911	172	17,500	43,300	187,000	200
MIKADO	MK-5,6	1913-1915	35	24,500	51,080	210,000	200
2-10-2 SMALL	F-1	1917-1919	52	68,000	65,300	273,000	200
2-10-2 LARGE*	F-4,5	1922-1924	101	84,000	75,150	306,000	200
SOUTHERN PACIFIC*	SP-1,2,3	1925-1927	49	90,000	84,200	317,000	225
ARTICULATED CONSOLIDATION	AC-4	1928	10	130,500	116,900	475,200	235
ARTICULATED CONSOLIDATION	AC-8	1939	28	183,000	124,300	531,700	250
ARTICULATED CONSOLIDATION	AC-9	1939	12	202,000	124,300	531,200	250

* BOOSTER EQUIPPED

PAN.Y

ES PACIFIC LINES
40
ED TRACTIVE EFFORT

SUPERIOR COURT, PIMA CO.: ARIZONA
STATE v. S P CO. NO. 20087
DEFTS EX. NO. 5 (WITNESS RUSSELL)

TYPE	CLASS	YEAR PUT IN SERVICE	NUMBER PURCHASED	AVERAGE PRICE EACH	TRACTIVE EFFORT LBS.	WT. ON DRIVERS LBS.	BOILER PRESSURE LBS.	TENDER CAPACITY OIL GALS.	TENDER CAPACITY WATER GALS.
OGUL	M-4	1899-1901	103	$ 14,000	28,710	126,000	190	2,990	4,500
ON SOLIDATION	C-9,10	1905-1911	172	17,500	43,300	187,000	200	2,940	7,000
IKADO	MK-5,6	1913-1915	35	24,500	51,080	210,000	200	2,940	9,000
-10-2 SMALL	F-1	1917-1919	52	68,000	65,300	273,000	200	3,120	10,030
-10-2 LARGE *	F-4,5	1922-1924	101	84,000	75,150	306,000	200	4,000	12,000
OUTHERN PACIFIC *	SP 1,2,3	1925-1927	49	90,000	84,200	317,000	225	4,912	12,150
RTICULATED CONSOLIDATION	AC-4	1928	10	130,500	116,900	475,200	235	4889	16,452
RTICULATED CONSOLIDATION	AC-8	1939	28	183,000	124,300	531,700	250	6400	21,900
RTICULATED CONSOLIDATION	AC-9	1939	12	202,000	124,300	531,200	250	28 TONS COAL	22,120

* BOOSTER EQUIPPED

SUPERIOR COURT, PIMA CO., ARIZON.
STATE v. S.P.CO. NO. 20087
DEFTS. EX. NO. 6 (WITNESS)

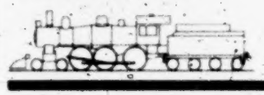
SOUTHERN PACIFIC COMPANY
PACIFIC LINES
CHRONOLOGY OF PASSENGER LOCOMOTIVES PACIFIC LINES
YEARS 1895 TO 1940
SHOWING IMPROVED DESIGN AND INCREASED TRACTIVE EFFORT

TYPE — WHEEL ARRANGEMENT (WHYTE SYSTEM)

TEN WHEEL 4-6-0

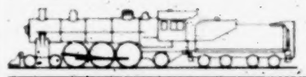
25260 LBS

TEN WHEEL 4-6-0



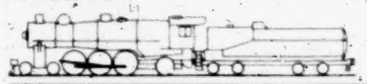
27590 LBS

PACIFIC 4-6-2



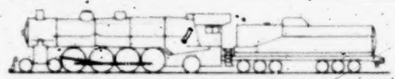
29920 LBS

PACIFIC 4-6-2



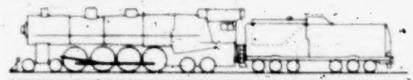
43660 LBS

MOUNTAIN * 4-8-2



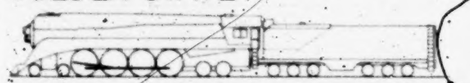
57510 LBS

GOLDEN STATE * 4-8-4



62200 LBS

GOLDEN STATE * 4-8-4



54800 LBS

TYPE	CLASS	YEAR PUT IN SERVICE	NUMBER PURCHASED	AVERAGE PRICE EACH	TRACTIVE EFFORT LBS	WT ON DRIVERS LBS	BOILER PRESSURE LBS	TENDER CAPACITY OIL GALS	TENDER CAPACITY WATER GALS
TEN WHEEL	T-1	1895-1897	39	$11,500	25,260	112,000	180	10.5 TONS COAL	4,000
TEN WHEEL	T-25	1901	8	14,000	27,590	134,000	200	10.5 TONS COAL	6,000
PACIFIC	P-5	1912	15	22,500	29920	141,000	200	2,940	7,900
PACIFIC	P-8	1921	15	72,500	43,660	180,000	200	4,000	12,000
MOUNTAIN *	M-1	1923-1924	28	82,000	57,510	246,000	210	4,000	12,000
GOLDEN STATE *	GS-1	1930	10	115,000	62,200	262,000	250	4,912	16,152
GOLDEN STATE *◆	GS-4	1940	20	173,000	64,800	276,000	300	6,275	23,500

* BOOSTER EQUIPPED
◆ PRICE AND WEIGHT OF THESE LOCOMOTIVES ESTIMATED BUT ADDED HERE FOR COMPARATIVE PURPOSES

MPANY

IVES PACIFIC LINES
940
ISED TRACTIVE EFFORT

SUPERIOR COURT, PIMA CO., ARIZONA
STATE v. S.P.CO. NO. 20087
DEFTS. EX. NO. 6 (WITNESS) RUSSELL

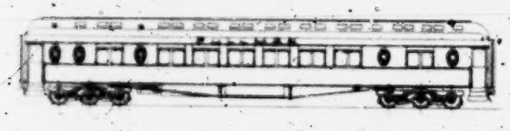
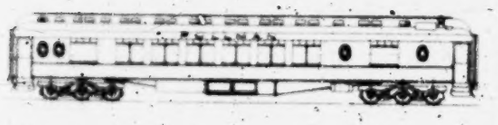
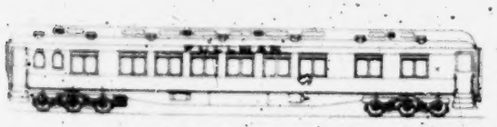
	CLASS	YEAR PUT IN SERVICE	NUMBER PURCHASED	AVERAGE PRICE EACH	TRACTIVE EFFORT LBS.	WT. ON DRIVERS LBS.	BOILER PRESSURE LBS.	TENDER CAPACITY OIL GALS.	TENDER CAPACITY WATER GALS.
	T-1	1895-1897	39	$11,500	25,260	112,000	180	10.5 TONS COAL	4000
	T-25	1901	8	14,000	27,590	134,000	200	10.5 TONS COAL	8000
	P-5	1912	15	22,500	29,920	141,000	200	2,940	7,000
	P-8	1921	15	72,500	43,660	180,000	200	4,000	12,000
	MT-1	1923-1924	28	82,000	57,510	216,000	210	4,000	12,000
ATE *	GS-1	1930	10	115,000	62,200	262,000	250	4,912	16,152
ATE *+	GS-4	1940	20	173,000	64,800	276,000	300	6,275	23,500

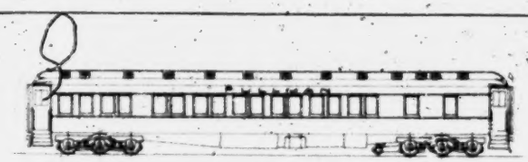
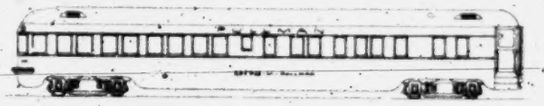
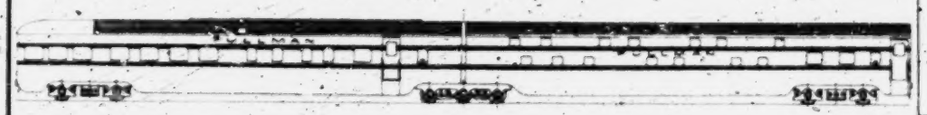
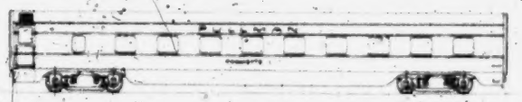
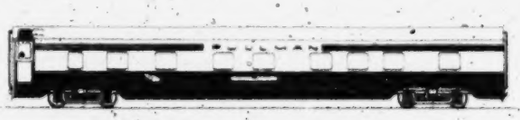
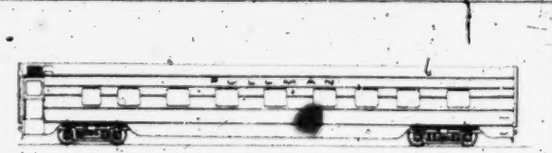
* BOOSTER EQUIPPED
+ PRICE AND WEIGHT OF THESE LOCOMOTIVES ESTIMATED BUT ADDED HERE FOR COMPARATIVE PURPOSES

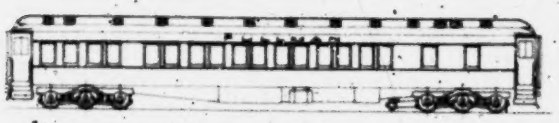
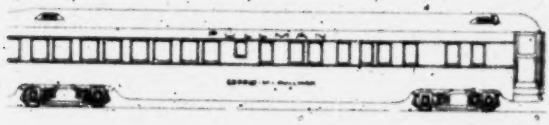
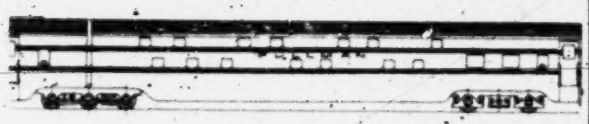
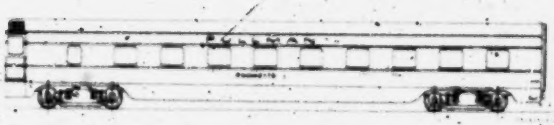
THE PULLMAN COMPANY

CHRONOLOGY OF ADVANCES IN SLEEPING CAR CONSTRUCTION

YEARS 1900 TO 1940

SIDE ELEVATION	YEAR	NEW FEATURES	LENGTH OVER PLATFORMS COUPLED	AVERAGE WEIGHT OF 6 TRUCKS	AVERAGE WEIGHT OF ONE TRUCK
	1900 1901 1902 1903	HELICAL SPRING DRAFT GEAR. NATIONAL COUPLERS WITH VERTICAL CENTERING DEVICE. WROUGHT IRON BODY BOLSTERS. WOOD & STEEL TRUSS RODS UNDERFRAME. WOOD BODY WITH WOOD & CANVAS ROOF & WOOD INTERIOR. WOOD FRAME VESTIBULE. P.M. BRAKE SCHEDULE ONE 14" CYLINDER BODY HUNG. M.C.B. 4 WHEEL TRUCK WOOD FRAME STEEL PLATES. TRIPLE BRAKES. 4½" x 8½" JOURNALS. HAND BRAKE BEAMS. PRESS PLATE STEEL WHEELS. 36"-24" "SAFETY" HOT WATER HEAT. PINTSCH GAS LIGHTING. 78" STEAM TRAINLINE.	78' - 10"	120,000 lbs	9,000 lbs
	1904	NATIONAL COUPLERS WITH CARRIER CENTERING DEVICE. P.M. BRAKE SCHEDULE ONE 8" CYLINDER BODY HUNG. M.C.B. 4 WHEEL TRUCK WOOD FRAME STEEL PLATES. TRIPLE BRAKES. 5" x 9" JOURNALS. DIAMOND SPECIAL FORGED STEEL BRAKE BEAMS.	80' - 9"	122,000 lbs	9,000 lbs
	1906	WESTINGHOUSE D-3 WEDGE TYPE FRICTION DRAFT GEAR. BUMPER & STEAM COUPLERS. CAST STEEL BODY BOLSTERS. WOOD & STEEL VESTIBULE. L.N. BRAKE SCHEDULE TWO 12" CYLINDERS. GAS & ELECTRIC LIGHTS WITH WOOD END ELECTRIC UNIT.	81' - 6"	124,000 lbs	19,000 lbs
	1907	FIRST ALL STEEL STRUCTURE PULLMAN CAR. TRUSS ROD STEEL UNDERFRAME WITH 10" I BEAM SILLS. STEEL BODY WITH STEEL PLATE EXTERIOR. STEEL ROOF. STEEL VESTIBULE. P.M. BRAKE SCHEDULE WITH ONE 12" CYLINDER. GAS & ELECTRIC LIGHTS WITH BATTERIES	80' - 5"	165639 lbs	20,300 lbs
	1910	BOD STEEL WITH INTERLOCKING STEEL SHEATHING. EXTERIOR STEEL ROOF & STEEL VESTIBULE. COMBINATION CAST STEEL PLATFORMS & BOLSTERS. BUILT UP STEEL CENTER SILLS & DEEP STEEL INTERIOR. M.C.B. CAST STEEL TRUCK 5½" JOURNALS TRIPLE BRAKES. P.T.T. COUPLERS "PARCE HEART". ELECTRIC LIGHTS WITH BELT DRIVEN GENERATOR.	81' - 10"	150,000 lbs	22,000 lbs
	1911	P.C. 30 = SCHEDULE WITH TWO 16" CYLINDERS	81' - 10"	150,300 lbs	22,000 lbs
	1912 1913	CARCO TRUSSED TYPE STEEL BRAKE BEAMS. VESTIBULE STEEL U-BEAM CONSTRUCTION. ROLLED STEEL WHEELS 36" DIA.	81' - 10"	151,100 lbs	22,000 lbs
	1918	BUILT UP STRUCTURAL STEEL BOLSTERS & PLATFORMS	81' - 10"	153,300 lbs	22,000 lbs
	1916	NEW STRUCTURAL STEEL FRAMING WITH STEEL PLATE EXTERIOR. M.C.B. BRAKE SCHEDULE WITH TWO 15" CYLINDERS OR ONE 18" CYLINDER.	81' - 10"	153,800 lbs	22,000 lbs
	1917	CLASP BRAKE SYSTEM FIRST APPLIED TO NEW TYPE 10 2440 CAST STEEL 6-WHEEL TRUCK. FORGED STEEL BRAKE BEAMS SIMPLEX TYPE.	81' - 10"	154,000 lbs	22,400 lbs
	1920 1921	WESTINGHOUSE TYPE H-2-A FRICTION PLATE DRAFT GEAR TYPE "D" COUPLERS QUADRUPLE SLEEPY HOLLOW. NEW NO.80 CAST STEEL TRUCK WITH CLASP BRAKES. STANDARD CLASP BRAKES. 2" STEAM TRAINLINE. WEIGHT OF CAR INCREASED.	81' - 11¾"	159,000 lbs	22,800 lbs

SIDE ELEVATION	YEAR	NEW FEATURES
	1923	LENGTH OF CARS INCREASED. WEIGHT OF CARS INCREASED.
	1927	NEW 2611 CAST STEEL TRUCK. WABCO FRICTION PLATES DRAFT GEAR. 2" STEAM TRAINLINE HEATING. FIRST MECHANICAL AIR CONDITIONING SYSTEM TRIED OUT ON EXISTING CAR.
	1929	FIRST TEST APPLICATION OF AIR CONDITIONING SYSTEM TO
	1933	FIRST ALL ALUMINUM LIGHT WEIGHT SPECIAL WABCO RUBBER TYPE DRAFT GEAR. SPECIAL TYPE "D" COUPLER BUILT UP STEEL CENTER SILLS. P.S.F. FORGED ALUMINUM ALLOY SIDE POSTS. U.C.B.C. BRAKE SCHEDULE 15" DIA. CYLINDERS. SPECIAL 4-WHEEL TRUCKS, LATER CHANGED TO 6-WHEEL CAST STEEL TRUCKS. ALUMINUM ALLOY UNDERFRAME.
		ALUMINUM ALLOY BODY, BOLSTERS, SIDE SILLS. ALUMINUM ALLOY ROOF. 2" STEAM TRAINLINE. ALUMINUM ALLOY VESTIBULE SHEATHING. VAPOR HEAT. AIR CONDITIONING.
	1934	ALL ALUMINUM ARTICULATED STREAMLINED "CITY OF PORTLAND". ALUMINUM
	1935	AXLES WITH LARGER WHEEL SEATS. ENTRANCE DOOR FOR CONVENTIONAL CAR.
	1936	LIGHT WEIGHT TWIN CAR UNIT. SHORTER CLEAR TYPE HIGH TENSILE COUPLERS. SPECIAL WABCO RUBBER HAT DRAFT GEAR. U.C. BRAKES WITH TRUCK HUNG CYLINDERS. TRUCKS TWO 4-WHEEL TRIPLE BOLSTER. ONE 6-WHEEL DOUBLE BOLSTER. ROLLER BEARING JOURNALS 3½" DIA. WHEELS UNIVERSAL BODY BOLSTER. HIGH TENSILE STEEL. BUILT UP ALLOY STEEL VESTIBULE.
	1936	CITY OF LOS ANGELES. STREAMLINED. CITY OF SAN FRANCISCO STREAMLINED. CITY OF DENVER. STREAMLINED.
	1937	FIRST WELDED GIRDER TYPE STEEL CAR STRUCTURE. WABCO RUBBER HATT DRAFT GEAR. M.S.C. BRAKE SCHEDULE WITH TRUCK HUNG CYLINDERS. HEAT TREATED 3½" DIA. STEEL AXLES. 2½" STEAM TRAINLINE. TRUCKS 4 WHEEL NICKEL STEEL. AIR CONDITIONED.
	1938	NEW LIGHT WEIGHT HIGH TENSILE STRUCTURE WITH TRUSS FRAME. STAINLESS STEEL EXTERIOR ALLOY. BRAKES M.S.C. SCHEDULE WITH 14" BORE CYLINDERS. TRUCKS 83.K. 4 WHEEL TRIPLE HIGH TENSILE STEEL FRAMING. EXTERIOR. 6½" x 10" JOURNALS.
	1939	WABCO THIN TYPE RUBBER DRAFT GEAR. TRUCKS 6 AND 4-WHEEL STOCK. HELICAL BOLSTER SPRINGS AND 2 STAY RODS.

SIDE ELEVATION	YEAR	NEW FEATURES	LENGTH OVER PLATFORMS COUPLED	AVERAGE WEIGHT CAR & TRUCKS	AVERAGE WEIGHT ON ONE TRUCK
	1923	LENGTH OF CARS INCREASED. WEIGHT OF CARS INCREASED.	82'-11⅝"	161 700 lbs.	22 800 lbs.
	1927	NEW 2811 CAST STEEL TRUCK. WABCO FRICTION PLATES DRAFT GEAR. 2" STEAM TRAINLINE METAL CONNECTORS. FIRST MECHANICAL AIR CONDITIONING SYSTEM TRIED OUT ON EXISTING CARS.	82'-11⅝"	170 000 lbs.	24 000 lbs.
	1929	FIRST TEST APPLICATION OF ICE ACTUATED AIR CONDITIONING SYSTEM TO EXISTING CARS.			
	1933	FIRST ALL ALUMINUM LIGHT WEIGHT PULLMAN CAR. SPECIAL WABCO RUBBER TYPE DRAFT GEAR. SPECIAL TYPE 'D' COUPLER. ROLLED STEEL WHEELS. U.S.S. FORGED ALUMINUM ALLOY BRAKE BEAMS. U.C.B.C. BRAKE SCHEDULE 16" DIA CYLINDER. SPECIAL 4-WHEEL TRUCKS, LATER CHANGED TO STD. 6-WHEEL CAST STEEL TRUCKS. ALUMINUM ALLOY UNDERFRAME AND BODY. ALUMINUM ALLOY BODY BOLSTERS BUILT UP TYPE ALUMINUM ALLOY ROOF. 2" STEAM TRAINLINE. ALUMINUM ALLOY VESTIBULE SPECIAL. VAPOR HEAT. AIR CONDITIONED.	84'-3"	119700 lbs.	
	1934	ALL ALUMINUM ARTICULATED STREAMLINER 'CITY OF PORTLAND' ALUMINUM CONSTRUCTION.	64'-6"	63 690 lbs.	6 200 lbs.
	1935	AXLES WITH LARGER WHEEL SEATS AND CENTERS INTRODUCED FOR CONVENTIONAL & LIGHT WEIGHT CARS.			
	1936	LIGHT WEIGHT TWIN CAR UNIT. QUARTER GIRDER TYPE HIGH TENSILE STEEL CAR STRUCTURE. SPECIAL WABCO RUBBER HAT DRAFT GEAR. TIGHT LOCK COUPLER. U.C. BRAKES WITH TRUCK HUNG CYLINDERS & 16" CYLINDER. TRUCKS: TWO 4-WHEEL TRIPLE BOLSTER. ONE 6-WHEEL DOUBLE BOLSTER. ROLLER BEARING JOURNALS: 36⅛" DIA ROLLED STEEL WHEELS. UNDERFRAME, BODY, BODY BOLSTERS & END HIGH TENSILE STEEL. AIR CONDITIONED. BUILT UP ALLOY STEEL VESTIBULE.	153'-0"	COMPLETE CAR 223 200 lbs.	4 WHEEL 19 600 lbs. 6 WHEEL 25 400 lbs.
	1936	CITY OF LOS ANGELES' STREAMLINER CITY OF SAN FRANCISCO' STREAMLINER CITY OF DENVER' STREAMLINER	ALUMINUM 64'-10⅝" CONSTRUCTION 64'-10⅝" 69'-6"	70 434 lbs. 69 660 lbs. 70 980 lbs.	18 738 lbs. 18 434 lbs. 19 666 lbs.
	1937	FIRST WELDED GIRDER TYPE HIGH TENSILE STEEL CAR STRUCTURE. WABCO RUBBER HATT DRAFT GEAR. H-5-C BRAKE SCHEDULE WITH FOUR 12" TRUCK HUNG CYLINDERS. HEAT TREATED 36⅛" DIA STEEL WHEELS. 2½" STEAM TRAINLINE. TRUCKS 4 WHEEL NICKEL STEEL TRIPLE BOLSTER AIR CONDITIONED.	84'-6"	130 690 lbs.	18 850 lbs.
	1938	NEW LIGHT WEIGHT HIGH TENSILE STEEL CAR STRUCTURE WITH TRUSS FRAME & CORRUGATED STAINLESS STEEL EXTERIOR ROOF & SIDE WINDOWS. BRAKES H.S.C. SCHEDULE WITH FOUR 12" TRUCK HUNG BRAKE CYLINDERS. TRUCKS 4'-0" 4-WHEEL TRIPLE BOLSTER. HIGH TENSILE STEEL FRAMING STAINLESS STEEL EXTERIOR. 5½"x10" JOURNALS	84'-6"	116 000 lbs.	18 400 lbs.
	1938	WABCO THIN TYPE RUBBER DRAFT GEAR TRUCKS 4'-0" 4 WHEEL DROP EQUALIZER. HELICAL BOLSTER SPRINGS. SHOCK ABSORBERS & STAY RODS.	84'-6"	126 800 lbs.	19 000 lbs.

BRAKE SCHEDULES.

P.M. EMERGENCY BRAKING RATIO 127% REDUCED DURING STOPPING TIME.

L.N. EMERGENCY BRAKING RATIO 150% MAINTAINED THROUGHOUT STOP.

P.C. EMERGENCY BRAKING RATIO 180% WITH EMERGENCY AFTER LIGHT SERVICE APPLICATION DESIGNED FOR 110 lbs. TRAIN LINE PRESSURE.

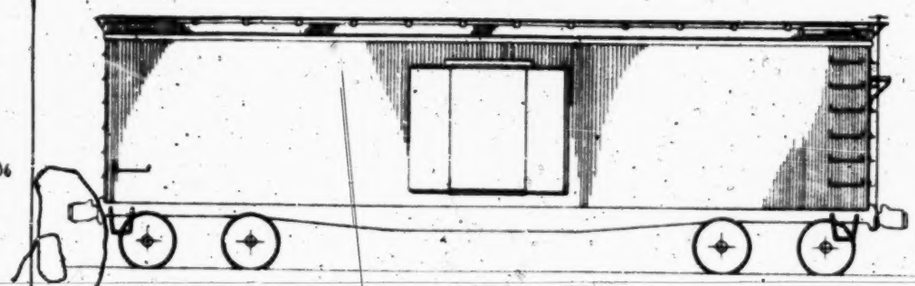
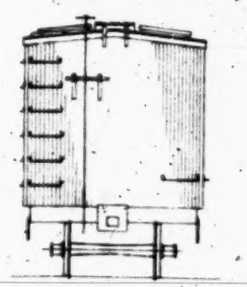
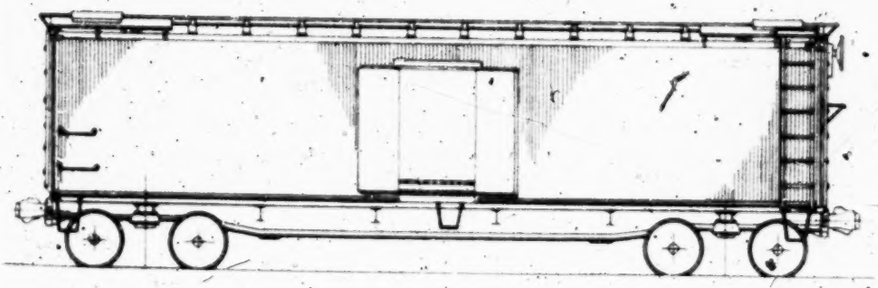
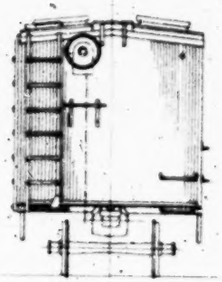
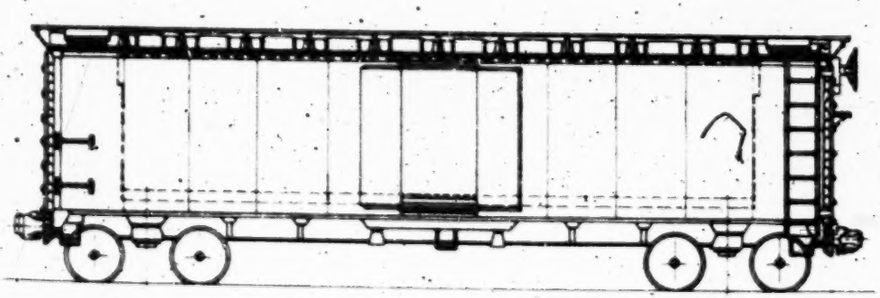
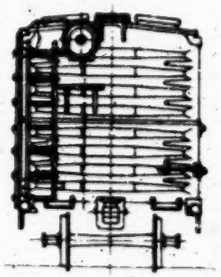
U.C. SAME AS P.C. EXCEPT IT CAN OPERATE AT ANY BRAKE PRESSURE.

H.S.C. OPERATES SAME AS U.C. CAN BE CONNECTED FOR HIGHER BRAKING PRESSURES & ELECTRO PNEUMATIC CONTROL.

THE PULLMAN COMPANY
OFFICE OF CHIEF ENGINEER
PULLMAN BLDG. CHICAGO, ILL.

Superior Court, Pima Co., Arizona
State v. S.P. Co. No. 20087
Defts. Ex. No. 4.2 (Witness

CHRONOLOGY OF PACIFIC FRUIT EXPRESS FREIGHT REFRIGERATOR CARS
YEARS 1906 - 1936
SHOWING DESIGN AND CAPACITY CHARACTERISTICS

YEAR	A SIDE ELEVATION	B END ELEVATION	C NEW FEATURES	D CARRYING CAPACITY & WEIGHT LBS.	E CUBICAL CAPACITY CU.FT.	C
1906			10" Air Brake Cylinder Triple Valve B-1 Brake Beam 1" Truss Rod Pressed Steel Underframe Arch Bar Trucks 4-1/4" x 8" Journals Cast Steel Coupler 5" x 7" MCB Shank Carmer Release Rigging Tandem Spring Draft Rigging Drop Forged Coupler Yoke Simplex Truck Bolster Wheels Cast Iron Wood Superstructure " Roof	60000 44500	1964	
1930			Triple Valve K-2 Struct. Steel Built up Underframe Cast Steel Truck Side Frames 5" x 9" Journals Brake Beam Safety Supports Bottom Rod Safety Guard Cast Steel Truck Bolster Type "D" Coupler 6" x 8" Shank Coupler Centering Device Improved Cast Iron Wheels (Single plate) Friction Draft Gears Cast Steel Coupler Yokes Rotary Coupler Release Rigging No. 24 Brake Beam 1-1/4" Truss Rod Additional Handhold Side and End Ladders Metal Brake Steps Power Hand Brakes Steel Superstructure Flexible Metal Roof	80000 52500	1988	
1936			AB Brakes Steel Underframe with Corten Steel Center Sill Double Truss Spring Plankless Truck Loop Type Brake Hangers and Wear Plates Type "E" Coupler Truck Snubber Springs No. 3 Brake Beam 1-3/8" Truss Rod Steel Sheathing and Framing Steel Ends Solid Steel Roof	80000 53100	1988	

Superior Court, Pima Co., Arizona
State v. S.P. Co. No. 20087

Defts. Ex. No. ____ (Witness _____)

D CARRYING CAPACITY & WEIGHT LBS.		E CUBICAL CAPACITY CU.FT.	F CROSS SECTIONAL AREA CENTER SILL - SQ. IN.
60000	44500	1964	20.81
80000	52500	1988	28.44
80000	53100	1988	18.40